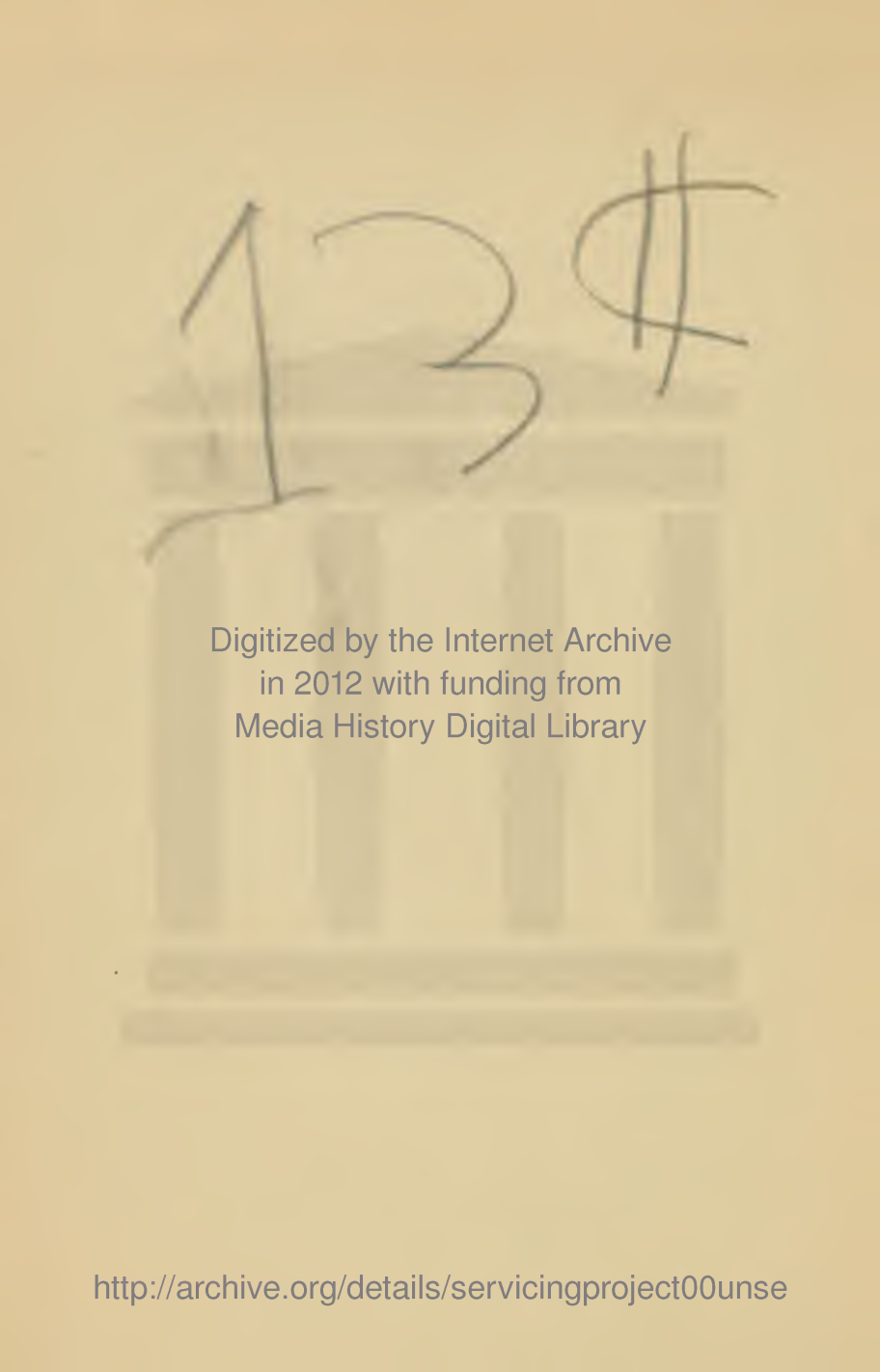
SERVICING PROJECTION EQUIPMENT



SERVICING PROJECTION EQUIPMENT

SERVICING PROJECTION EQUIPMENT

MANCALL PUBLISHING CORP.
New York

1st Printing

292

Made in the U. S. A.

Contents

(Arranged Alphabetically)

SERVICING PROJECTION EQUIPMENT

ARC

1. Look Under Light Source

ARC CONTROLLER

Only that which you see at the device itself, is covered here. The feeding rate, etc., are seen elsewhere than at the controller, and are therefore covered under the proper headings.

1. Device Operates Poorly

(a)—The electrical connections may be poor and the contacts dirty or corroded. Examine and tighten any loose binding posts or screws. Clean the corroded contacts.

(b)—Changes in the line voltage may be affecting the arc and, since the controller is connected across the arc, it affects the device. This causes changes in the motor speed and in the timing of the governor or the relay. If the line voltage rises or

drops and then becomes steady, adjust it for new conditions. If it fluctuates seriously on a line test, notify the supply company.

(c)—A bad carbon jaw, which should be tested and corrected, may be affecting the arc voltage.

(d)—The motor may be dirty, oily, etc. Inspect the motor, and if any fault is found there, look under *Motors and Motor Generators.*

2. Device Fails to Operate

Warning: Arc Controller Motors, unless otherwise specifically noted by the makers, are Direct Current Motors and are invariably connected across the arc; therefore, when changing from the usual D. C. to A. C. for emergency operation, do not use devices which have such D. C. Motors.

(a)—The device is being used on A. C. when intended for use on D. C. See the above warning.

(b)—The motor is damaged by throwing-in on A. C. The only remedies are the repairing of the damage or the procurement of a new motor.

(c)—The wires or connections may have been broken, loosened, or disconnected by the vibration of the motor or by a jar. These parts should be examined, and then repaired or tightened.

(d)—The relay, the governor, or any other governing mechanism is either broken or binding

(*infrequent*). If this condition is discovered, disconnect the mechanism and feed by hand until a repair is effected.

(e)—The line voltage may be low. If the arc is also operating below par, test the arc voltage. If the trouble lies there, look under *Light Source* under the proper heading for the type you use.

3. Device Continues to Operate After the Table Switch is Opened

(a)—The device may be connected to the wrong side of the table switch. It should be connected to that side of the switch which is dead when the switch is open. If this is found at fault, connect it properly.

BELL OR BUZZER SIGNAL SYSTEM

1. Bell (or Buzzer) Does Not Operate

(a)—The battery is either low or dead: therefore, test its voltage. If it is dry cell battery and its voltage is low, replace it; if it is a wet cell battery and its voltage is low, replenish it.

(b)—Probably a disconnected wire is the cause. Examine the contacts and connections and tighten or repair them.

(c)—Dirty and loose contacts are sometimes the cause. They should be examined, then cleaned and tightened.

(d)—Dampness may have rotted the insulation, causing a short circuit. Look at any part of the system that is in a place likely to be constantly damp. Examine the wiring and insulation for wear or a break and replace them, if required.

(e)—A short circuit is another common cause. It may deaden the system or the individual bell and will, most likely, be found in the wire which, leading from the bell to the battery, makes a contact with the wire leading from the bell to the button.

Trace these wires for the short circuit; and if it is found, separate the wires and insulate them against repetition.

(f)—Test the ringing device; and if it is found faulty, repair or replace it.

(g)—The push-button contact may be defective:—therefore, it should be tested and corrected.

2. Device Operates Intermittently

(a)—Examine all connections, and if they are loose, test and tighten them.

(b)—A poor button contact may be the cause:—therefore, clean or replace the defective contact.

(c)—Another probable cause is a low battery. Test the voltage, and if it is found low, replace the battery (if a dry cell), and (if a wet cell), replenish it.

3. Bell (or Buzzer) Sounds Continuously

(a)—The button may be defective. Note if the button springs free of the contact when finger pressure is removed; the cause is evident if it does not. Clean away the dirt or repair the spring—and, if necessary, replace the defective part.

(b)—A short circuit between the wires leading to and from the push-button may be the reason. If these two touch, the signal will continue until they

are separated; therefore, insulate them against a possible recurrence of the trouble.

4. System Works When New Battery is Used But Soon Fails to Operate

(a)—This is probably due to a short circuit which runs down the battery. If the bell does not sound and it works when the buttons are pressed, but the battery weakens rapidly, look for a short circuit leading to another wire, or to any other paths through which the current can leak away.

DOUSERS

1. Dousers Open and Close Too Early or Too Late

(a)—The switch may stick and in this way upset proper operation. Test and correct it by lubrication, if it is found faulty. The switch should be lubricated constantly to avoid a recurrence of this trouble.

(b)—Dirty and loose contacts, which should be checked and remedied, are probably affecting the timing.

(c)—The switch probably does not make a simultaneous contact with the contact units, and should be examined and corrected.

2. Dousers Fail to Operate

(a)—An open circuit may be the reason for this trouble. If a broken circuit is found to be the cause, trace and then remedy it.

(b)—Should the coil be burned out examine it and, if necessary, replace it.

3. Dousers Open or Close Too Far

(a)—The adjustment that controls the travel is not correct. Usually the bumper, or any other device regulating the travel, can be set by the use of a handy adjustment. Test and correct it by moving it in or out until it is in the correct position.

4. Dousers Will Not Stay Open During Running

(a)—The spring holding the douser open is defective or weak. Try giving more tension by bending or stretching the spring. If this fails to hold the douser, a new spring will have to be installed.

FILM

Troubles Noted Upon Examination of the Film

1. Film is Unusually Dry or Brittle

(a)—This is due to improper storing before reaching the projection room, or to carelessness in the projection room storing. Another reason may be that not enough water is kept in the storage moistener compartment. The film must be moist enough to be pliable or else trouble in the projector and damage to the film will be marked. See that the moistening is correct in the projection room storing place.

2. Film Adheres in Spots

(a)—The reason for this may be that some water has accidently deposited on the film and had not dried fully prior to rewinding or packing. Extra care should be used in separating the layers in order to avoid ruining the emulsion on the film.

(b)—If water has been deposited on the film in the theatre or projection room do the following: If the film is freshly wet, it may be possible to

separate the layers without excessive damage, provided that extreme care is used in separating the surfaces. To dry the film spread it so that it cannot touch anything dirty and so that its surfaces do not touch each other. Avoid dust and abrasives touching the film until it is thoroughly dried.

Warning: Never roll film when it is damp or water-spotted, or else the emulsion and the pictures on the surface will be ruined.

3. Film Adheres Throughout Its Entire Length

(a)—In all probability the film is kept too moist. If it is a new print and can, with care, be separated without destruction, stretch it in a dry, dustless place and let it dry up a little more. If old film is so moist that it adheres, it probably cannot be separated without causing damage. Try very carefully to separate it and if it begins to show damage, substitute another subject or get a substitute print from the exchange.

(b)—The reel may have been spattered or may have been dropped into water. If of recent incidence and it can be caught in time, it may be separated and dried in a dustless place.

Warning (new film): When receiving new film handle it carefully. The emulsion of new film is especially soft and is subject to damages and scratches which cause "rain" and other defects.

FILM

DURING PROJECTION

1. Film Pulls Apart in the Projector

(a)—A weak splice made with a too narrow margin of film is sometimes the cause for this trouble. To remedy this make a wider lapover on the splice.

(b)—A poor grade of cement is used and therefore does not hold as tightly as a higher grade cement.

(c)—Improper, insufficient pressure is applied while the film is in the process of welding. A patch held between the fingers while setting seldom holds. It is advisable to use a standard splicing machine for all splicing jobs.

(d)—Because of careless scraping the emulsion is not entirely removed and therefore the cement does not actually weld the two film surfaces properly.

(e)—Failure to match the sprocket holes causes the splice to jam and, if it is weak, to pull apart.

(f)—Too much projector tension causes an undue strain and pull on the film. Examine and adjust it. Look under *Projector, Mechanical Troubles.*

(g)—A bent reel in the upper magazine binds, catches, and strains the film. Examine the reel and in the future use only perfect, true reels.

(h)—The upper reel is crammed too full, therefore, the layers of film rub, bind, and catch. *Never* fill the reel up to the edge.

2. Film Runs Off Sprocket Damaging Film

(a)—This may be caused by poor splices with the holes not correctly matched. In making splices, take care to see that the sprocket holes match and overlap on both sides of the splice.

(b)—There may be some worn, hooked sprocket teeth in the projector, which should be examined and replaced, if necessary. Reversing the sprocket on the shaft will not help this condition.

(c)—A tight, uneven tension causes the film to climb the sprocket teeth.

(d)—The idlers, perhaps, are improperly set.

(e)—The intermittent sprocket shoe may be incorrectly set.

(f)—The sprockets may not be lined up correctly.

(g)—The guide rollers may be either incorrectly set or loose.

3. Film Pulls Apart Where Old Style Friction Take-up is Used

(a)—Excessive tension may be the cause in this type of take-up, for even fairly strong splices may give. Therefore, adjust the friction take-up very carefully and thus avoid much film damage and splicing trouble.

4. Film Rips and Tears While Being Projected

(a)—A loose splice, the edges of which are not secure, may be catching on the sprocket idler. Be sure that all patches are tight not only in the center but the full width across.

(b)—Improperly matched sprocket holes may be the cause. The film may, as a result, wrap around the sprocket teeth, jam, snarl up, and rip or split. Care in matching the sprocket holes will save much trouble, especially if the matching is perfect at both sides of the patch.

(c)—Split sprocket holes are apt to catch on the sprocket idler. When inspecting the film take out all dangerous sections so that bad film does not have to go through.

(d)—The groove is worn in the fire valve casting and may be causing the film to catch on the edge. Examine and correct the cause of the trouble.

FILM

(Inspection After Running)

Damage Noted in Film After the First Run—Especially in New Film.

(a)—Torn edges, splits, and "V's" are due to the same causes as those under *Film During Projection.*

(b)—Rain and scratches on the film are largely due to:

1. Emulsion deposits on the tension shoes.
2. Emulsion deposits on the aperture plate tracks.
3. Emulsion deposits on the fire valve.
4. Rollers which do not roll and rollers which are out of line with the take-up sprocket.
5. Emulsion deposits on the aperture.

(c)—Excessive tension will cause increased difficulties with the emulsion deposits. Adjust the tension to as light a degree as possible, being sure,

however, that this does not cause unsteadiness. This should be done especially when about to run new film.

(d)—Too much cement may have been used in splicing. Cement, when combined with moist, or soft emulsion, has a tendency to form a hard, abrasive compound which, deposited upon the shoes, etc., is injurious to the film.

Warning: When removing the deposit do not use a sharp instrument. The best method is to use water which softens the deposit readily and permits wiping off with a rag. Be sure to dry the parts thoroughly after cleaning them in this manner.

FILM

After Rewinding

1. Film Shows Tears and Nicks

(a)—The rewinding elements which are not in line may be causing the film to catch on the edges of the reel, to snarl and tear, and to jump the edge of the reel when the reel is nearly full. The only remedy is to line-up the elements.

(b)—The brake on the free reel, which should be adjusted, is perhaps inactive or out of adjustment and, therefore, allows the free reel to overrun and to permit the film to run too loose.

(c)—Too rapid rewinding causes the film to slash and jump and is a source of much damage, especially if a bent reel is used or the brake fails to work.

2. Film is Unusually Dirty and Dusty After Rewinding

(a)—This may be due to a poorly surfaced projection room floor from which dust gathers in the air and settles on the film and apparatus during

rewinding and handling. Dust is especially likely to cause harm if the film is stored on the rewind table. Keep such poorly surfaced floors very clean or else have them re-surfaced.

3. "Rain" Develops While Running the Film

(a)—Dust and dirt have been allowed to collect in the projector. Keep the projector absolutely clean, and attend to this often enough to prevent the accumulation of dust, dirt, and oil from causing trouble.

(b)—Dirt, dust or oil may be on the film. These accumulate on the projector parts which are in contact with the film and then damage the balance of the film run through. Keep the film away from any contact with oil or dirt.

(c)—A too free use of cement in splicing may be the cause. This accumulates on the tension shoes, the sprockets, the aperture, and the track, and forms an abrasive. Use less cement and clear off any excess.

4. "Rain" Develops When Rewinding

(a)—Dirt, dust, or oil are on the film. Avoid the cause and prevent the trouble.

(b)—Rewinding with a heavy brake tension may be the reason for this trouble. The heavy brake tension causes the layers to be pulled against each

other on both reels thereby scraping the emulsion against the back of the adjoining layer. In this case any dirt or dust will also be scraped against the emulsion. Watch the brake tension.

(c)—Rapid rewinding or too loose brake tension allows the film to over-run and also permits it to wind up so loosely that it becomes necessary to "pull-down" in order to get all the film on the reel. Adjust the brake, rewind at the correct speed, and *never* "pull-down", since it is the cause of more "rainy" film than any other thing.

FUSES

1. Fuse Blows Out

(a)—A rise in the line voltage temporarily overloads the circuit. Locate the dead fuse and replace it.

Warning: Fuses are a protection against prolonged overloading of a circuit and they blow out before other parts can be damaged. Therefore, do not raise the fuse capacity, or wire around the fuses, or install fuses of a higher capacity than the rating calls for, or else the circuit may be seriously damaged.

(b)—A ground in the circuit becomes a path for amperage strain on the fuse capacity. If the new fuse blows out, look for a heavy ground or a short circuit.

(c)—This trouble may also be due to a short circuit in the line or in the device it supplies.

(d)—The overloaded capacity of the line and of the fuse may be the cause. Be sure that the fuses in the circuit are of a sufficient capacity to carry the current safely, allowing a small overload mar-

gin. However, do not "boost" the fuse capacity at any point as it will cause the device protective fuses to blow out.

(e)—Another common cause for this trouble is the use of old fuses which have been in service a long time and are more likely to blow out than new fuses.

2. New Fuse Blows After An Interval

(a)—Test, first, for another short circuit or ground.

(b)—If no ground or short circuit is found, look at the fuse contact points which may be dirty or corroded. Dirt or corrosion set up resistance which induces heat and the added amount may, after a time, attain a "blowing" temperature. Clean the points and inspect them occasionally; also be sure the contact is tight.

3. New Fuse Does Not Blow But the Line Remains Dead

(a)—This may be due to a defective fuse. Test with another which is known to be perfect.

(b)—An old, dead fuse may have been mistaken for a good one and may have been used by mistake. Throw away all fuses as soon as they blow out, except those which are especially designed for the renewal of their elements. Do not try to renew

any other kind; throw them away at once and avoid the danger of getting them mixed.

4. Fuses Blow Out When Arc Is Struck (Where 3-Wire System is in Use)

(a)—The carbon arm of the projector, if connected to the neutral wire of a 3-wire system, will become grounded. It also may be cutting out the rheostat resistance, thus overloading the fuse, when in striking the arc, a heavy current flows. If the resistance of the carbons and the ground combined is less than that formerly in the circuit on the rheostat, the fuse will blow out every time the arc is struck. Locate the ground and remove the cause. In cases where the lamphouse is permanently grounded, see if the carbon jaws are also grounded to the lamphouse. This grounding of the carbon jaws may be due either to carbon dust or to a broken strand in the contact or lead to the carbon jaws. If the trouble is not found at the lamphouse, look for a heavy ground elsewhere and eliminate it.

5. Fuse Locating: Easy Way to Locate Quickly in Emergency

(a)—Make a master list of all the panels, with a list under each panel heading of the circuits and their fuses. Number the fuses in each panel and place these numbers against the same circuits on

the list. Keep the list in a prominent place near a light for instant use when needed.

6. *Fuses: Emergency Measure When No Fuse Can Be Found*

(a)—If no fuse of correct amperage is available, a strictly temporary replacement may be used —that is, a single strand of No. 30 wire is capable of carrying approximately ten (10), amperes of current. To make an emergency fuse, combine enough such single strands to attain the amperage rating required and then connect them in place of the blown fuse, but be sure the other side of the line has its fuse in place and is intact. Replace this emergency connection with a correct fuse as quickly as possible. *Do not leave it there.* It is simply a makeshift and if it is neglected when new fuses are available, it may occasion difficulty with the electrical inspectors.

HOUSE LIGHTS

1. Some Lights Burn Too Brightly; Others Are Too Dim At Same Time

(a)—The neutral fuse of a 3-wire system is blown out, thus causing the effect, due to the unbalancing of the circuits, of some lights burning dimly and some lights burning brightly. Inspect the fuses at the intake and at the distributing points and replace them wherever necessary.

(b)—If the replaced fuse blows out, there is a short circuit or else the circuits are so far out of balance that the current drain is greater than the correct fusing permits. Test with an ammeter for the amount of unbalancing and relocate the circuits so as to obtain the correct conditions of balance which, on a 3-wire system, should be as near even on both sides as circumstances permit.

2. Emergency Lights Go Out; House Lights Still Burn

(a)—The emergency light circuit may have blown out. Trace the line and inspect the fusing, for in this case, the fusing should be separate from the house fuses. Replace the blown fuse.

(b)—If the fuse blows out again, trace the line for a short circuit, especially if the wiring is exposed to weather conditions or to any movement that would rot or rub the insulation enough to permit the wires to touch or to ground on metal.

LAMPHOUSE

This section applies to the housing of the mechanism only. Troubles with Lamp, Carbons, etc., are listed under LIGHT SOURCE where they are actually observed.

1. Lamphouse is "Alive"

It is charged with electricity and produces a shock, if touched.

(a)—It may be an older type of lamphouse. See whether the lower jaw of the lamp, when it is tilted, touches the metal of the lamphouse. If so, insulate it with a sheet of non-conductive material such as asbestos between the jaw and the housing.

(b)—In the newer model lamphouses when the metal is "alive," it is probably due to the following reasons:

1. The lamphouse is not grounded.

2. The ground connection to the lamphouse has been disconnected and a ground has allowed the current to escape from the carbon current-carrying jaws, arms or contacts. If the lamphouse is

not grounded, a serious "jolt" may result from a heavy current leakage into the metal. If the lamphouse is grounded and you still get a shock, test the ground at once, for a loose connection, damaged wiring, or a poor contact with the "earth."

2. Lamphouse Becomes Overheated

(a)—Ashes and dirt, which retain the heat of the lamphouse, are in or around the vent flue at the top and are constantly making the opening smaller. The vent flue should be cleaned regularly and kept free from obstruction. The same applies to the screen of the flue, provided one is used.

(b)—The vent flue and its screen should be cleaned as often as possible and preferably once a day during warm weather.

LAMP MECHANISM

1. Moving Parts of the Lamp Work With Difficulty

(a)—A lack of lubrication may be the cause. The working threads ought occasionally to be cleaned with kerosene, and while still wet, be dipped in graphite. The kerosene holds the graphite in place until the part is screwed home.

(b)—This procedure is especially important with carbon clamp screws. If the screws have to be set up tightly by the use of force or pliers, the excessive leverage may cause the carbons to crack. Powdered graphite, if used here as above, may save much trouble at this point.

2. Arcing Occurs Between Carbon and Jaws

(a)—This may be due to one of several things. First, there may be a poor electrical contact between the carbon and the jaws. Second, dirt may be the cause. Third, burned-out jaws may be the reason. Keep these parts free from scale by cleaning them daily. Replace them if they are old.

3. Carbon Jaws Pit and Roughen

(a)—Poor electrical contact generates exces-

sive heat. If the carbon jaws are kept clean and free from dirt, scale, and oil, the pitting is not apt to occur.

4. Arc Controller Underfeeds or Overfeeds

(a)—The line voltage may have changed. The controller relay, or motor, being connected across the arc, is affected by the arc voltage due to line fluctuations and must be readjusted to the new condition to enable the arc to work at full illumination and to have the carbons properly fed. Readjust the device to compensate for the change in the line voltage. Look below under the type of mechanism you use.

5. With Fulco-Speedco

Same Applies to Motor Gear-Box Types

(a)—The rods connecting the controller with the carbon feed may have been set in at so great an angle that the universal joints bind and do not work properly. Take care to have them as nearly perpendicular as possible, and if they are not so installed, see if it is possible to rearrange the position of the controller to get the proper alignment. This rearrangement will probably help the trouble.

(b)—A change in line voltage may be the cause. The adjustment to meet this condition is effected by readjusting the instant at which the

governor engages and disengages the feeding mechanism. A knob or nut is provided for adjusting the spring that controls the feeding time. First get the arc at the best operating point by hand regulation, then adjust the knob on the dial with the pointer so that this arc length is maintained.

Note: With this, as with other devices, it is a good plan to keep a tabulated check (over a period of time), on the settings that give the desired arc with the various line voltages that usually occur in your particular case. With this at hand you can always re-set quickly to cover such changes as are likely to come up in daily conditions.

Warning: Controller motors are invariably D. C. If, in an emergency, you change to A. C., do not use the controller motor. In that case disconnect the lead, or other contact, from the motor to the device and feed by hand while using A. C.

6. With Peerless Automatic

Same Applies to Motor Relay Types

(a)—The arc voltage governs the strength of the magnetic pull which gives contact in the relay to start the motor. The spring acts against this pull to open the motor circuit. By adjusting the spring tension, the instant of feed and stop can be regulated in this type. By such adjustment you regulate the arc length, and hence the arc voltage and the

magnetic strength and balance these against the spring tension.

To Adjust: Get the arc at its most perfect setting; then, with the controller motor feeding, set the spring, adjusting-screw, or knob until the motor just stops at that arc-length.

Warning: Never use the motor of this controller on A. C., and when changing from D. C. to A. C., disconnect it. Do not break the seal on the box guarding the relay: with the seal unbroken the guarantee is valid; with the seal broken, the guarantee is voided.

7. Motiograph Mechanical

Same Applies to Similar Types

(a)—The motor in this device runs continuously at an even, constant speed. The carbon feed and the speed of the carbon feed are regulated by the amount of the circumference of one friction disc being in engagement, by friction, with the circumferences of the friction discs which drive it. It is turned by them, thus regulating the degree of the engagement of these discs which regulates the speed of the carbon feed. An adjustment is provided by which more or less surface can be brought into engagement. To keep the arc conditions at the best point, regulation must match the rate of carbon consumption.

HIGH INTENSITY LAMP

Mechanical Troubles

1. H. I. Hand Feed Works With Difficulty

(a)—This is a natural condition, not a trouble, but is included to clear away any misunderstanding. If the hand feed works with difficulty, by hand, it is largely due to the fact that you must overcome the friction of the clutches and compel them to slip against the tension of the springs. If the hand feed refuses to operate, inspect it for dirt or overtight clamps. Do not permit the hand feed to operate too freely.

2. H. I. Arcs Between Positive, Negative, and Clamp

(a)—This may be due to a poor contact between the carbon and the clamp. Clean the clamp and keep it free from dirt, ash, carbon dust, and corrosion.

3. Arc Current Fails When Using D.C.

(a)—Disconnect the lead from the arc controller to the D.C. motor, shift to A.C. through the proper voltage transformer, and feed by hand.

4. H. I. Positive Carbon Fails to Feed

(a)—This may be due to the fact that it differs in relation to its mechanical control. However, the cause for this trouble may be the tightness of the mechanism which holds the carbon or the looseness or failure of the part that governs the feed. For adjustment, look under the different types which follow hereafter.

5. General Electric H. I.

(a)—The ratchet wheel is mounted on the rear end of the positive feed screw and the pawl is mounted on the stationary frame. The rotation of the carriage engages the pawl with the ratchet teeth. The setting of this, by screwing forward, engages more or less of each tooth and thus regulates the amount that the carbon feed screw rotates.

Adjustment: By turning clockwise the carbon feed is sped up; by turning counter-clockwise the carbon progression is reduced.

(b)—The lock nut on the pawl which adjusts the set screw has become loose and has disorganized the rate of feed it had originally been set for. Examine it and correct the feed rate, then tighten the nut and keep it tight.

(c)—The ratchet may not be engaged by the pawl. Note this and adjust it; and if the parts are damaged so that they do not engage, replace them.

(d)—The clamp may not be gripping the carbon tightly enough to overcome the friction of the other contacts, or the clamp locking piece may be bent. If it is bent, it should be removed and hammered straight.

6. Powers H. I. and New Type G-E

(a)—Same as General Electric H.I. Look under *High Intensity Lamp, Section 5.*

7. Ashcraft Automatic

(a)—The carbon is fed by two grooved rollers the edges of which grip the carbon and draw it forward at the period when the rotating mechanism is not rotating it. It is alternately moved forward and turned. If the carbon does not feed, it is due either to the fact that the tension shoes are gripping so tight that the rollers cannot overcome the friction and therefore, should be adjusted; or the rollers themselves do not grip sufficiently and should be adjusted.

(b)—The screw of the feed roller connection is too loose or the spring tension is too tight. These should be examined and corrected.

8. All Types

(a)—When the carbon fails to feed it may be due to the fact that the hole in the heat shield has

become smaller, due to corrosion, thus preventing the free movement of the carbon. This should be examined and cleaned.

Note: On all other makes the principles are the same and the causes of trouble are due to conditions similar to those mentioned under the sections treating of the various types.

9. Positive Carbon Fails to Rotate or Turn in Shield

(a)—This trouble may be due to the differing mechanical reasons in relation to the different types which will follow in the sections hereafter.

10. General Electric and Powers Improved Types

(a)—The tension of the contact shoes is too great and therefore it causes the carbon to stick or bind. Examine this, but first note the next cause for the trouble.

(b)—The carbon may not be clamped tightly enough to enable the torque to overcome the tension of the contact shoes. Adjust the carbon clamps tightly enough to function, but not so tight as to crack the carbons. Then, if it does not revolve, examine the tension of the contact shoes and adjust them tightly enough so that they will not bind but will still give current without interruption.

11. Ashcraft Automatic

(a)—The spring which causes the contact arms to hold the contact shoes tight may have too much tension, thus causing the carbon to bind. Test this and adjust it if necessary.

12. One Carbon Burns Out Quicker Than the Other

(a)—This may be due to the use of an incorrect current for the type and size you are using. Use only the recommended current for the sizes employed.

(b)—If the current is correct, it may be that the carbons themselves are at fault. Correct this condition by hand feeding the carbon at fault.

(c)—If the negative regularly burns away faster than the positive, use a negative of the next larger size.

(d)—If the positive regularly burns away faster than the negative, use a negative of the next smaller size.

MAZDA FILAMENT LAMP

Mechanical Troubles

1. Mirror Breaks Upon Insertion or Soon Afterward

(a)—The thumb screws or any other device is tightened down with too much force. Use only enough pressure to make the mirror secure but not so much as to strain it.

2. Mirror Looks Dull or Dirty

(a)—It is not properly cleaned or else it is not cleaned often enough. The best method for cleaning the mirror (which should be done quite often), is to employ a mixture of half wood-alcohol and half water, using only a very soft, perfectly clean cloth and polishing it with a fresh, soft cloth, while it is still wet.

Warning: Be careful to avoid dirty, dusty rags as they will ruin the mirror surface and cause such great trouble as to necessitate a replacement of the mirror.

REFLECTOR ARC LAMP

Mechanical Troubles

1. Mirror Backing Continually Chips or Flakes Off

(a)—A cheap grade of mirror whose backing is poor in heat resisting qualities, is being used. Use only mirrors made by reputable manufacturers.

(b)—Perhaps the wrong sort of cleaning materials are being used. It is advisable to use only those recommended by the makers of the mirror. The careless use of ammonia should be avoided, especially so if it is part of the cleaning fluid used, for ammonia may seriously damage the backing if allowed to get on it and dry in.

(c)—The current used may be too high for the rating of the lamp or the type of carbons employed, thus causing the heat to break down the mirror backing. Avoid excessive currents, if the trouble comes from this source, and use only the proper size carbons. The lamp makers' instructions concerning the current and the carbon size and types should be followed explicitly.

2. Mirror Surface Pits

(a)—Small particles thrown off the carbons can cause much damage to the surface, especially so when the carbons are close to the mirror. Metallic-coated carbons are usually a constant source of this trouble.

3. Occasional Aperture Fires Occur When Using Reflector Arc

(a)—The arc may be much too close to the front of the lamphouse, thereby giving evidence of light loss. If the light loss is very great, it is evident that the arc has not been adjusted for best results. If the arc has been moved away from the mirror and aperture fires begin, adjust the arc properly.

(b)—This may also be due to the sticking of the fire shutter. If fires occur at or near the end of a reel, inspect and clean or adjust the fire shutter.

LIGHT SOURCE

Effects noted at, and in, the arc itself, and conditions in the picture which may or may not register on the screen. Where trouble registers at the arc and also in the picture you will find the causes repeated under both heads to avoid the need for cross-reference.

1. No Current at Arc

(a)—The switch may be open on the line.

(b)—The fuse may be blown out on the circuit. Examine the fuse and if necessary replace it. Look under heading *Fuses.*

(c)—A contact may be broken, loosened, or disconnected. Note the lamp contacts first, then those leading to the table switch, the rheostat, the transformer, and the rectifier, and finally those leading to the main line switches and fuses. These fuses should be repaired or tightened wherever necessary.

(d)—The line may have gone dead due to a dynamo breakdown. First inspect the main line

fusing and test it for current. If no current is evident, switch to an emergency supply source.

(e)—The rectifier (Mercury Arc) may have developed trouble. Examine the rectifier, and if it is the source of the trouble, look under the heading *Mercury Arc Rectifier.*

(f)—The rheostat may have burned out or the coils may have been grounded or shorted. If the trouble is located here, look under heading *Rheostat.*

(g)—The motor generator set, if one is used, may have developed a defect. Look under *Motor Generators.*

(h)—If A.C. is used, the transformer may have become shorted. Inspect the transformer, and if it is irreparably damaged it must be replaced. Should a replacement be unavailable, see if the broken wire of the coil can be bridged or spliced with good insulated wire. In case this can be done, do not add any more wire to the coil than is absolutely essential, for the relative proportions of secondary to primary affect the step-up or step-down ratio and also affect the current delivery.

(i)—If D.C., taken direct from the supply line is used, test for the following: blown out fuse, damaged rheostat, and short circuits.

(j)—With series arcs: if arc went out as other was struck, look for imperfect carbon contact in

lamp just thrown in. Opening of short circuiting switch may have broken circuit completely.

2. Series Arc: One Goes Out When Other Arc Is Struck

(a)—*(Look under Section 1., division (j), immediately preceding).* A dirty or broken contact will cause a complete break of the circuit. Clean or tighten these contacts and see that the carbon makes a good electrical contact with the jaws.

3. Polarity Changes So That Upper Carbon Becomes Negative

(a)—When a small D.C. plant, which takes its current direct from the line, is used, it is possible that one dynamo is cut out and a new one, the polarity of which is opposite to that of the former dynamo, is brought in on the circuit. In a locality where this happens, a D.P.D.T. switch, so wired that the throwing of the switch from one side to the other will reverse the connection of the carbon leads to the line, should be provided. This in order that the switch can be thrown in any direction to keep the carbons on the correct lead whenever the line shifts polarity.

4. Brilliance of Arc Seems Less Than Usual

(a)—The carbon arms may be grounded to the lamphouse thereby reducing the strength of the

current. The carbon arms should be tested for a ground and remedied if necessary.

(b)—The lamp or switch contacts may be badly corroded and the lamp leads or contacts damaged or burned out through overheating. Test these and repair or replace them.

5. Arc is Very Unsteady

(a)—The carbons employed are of a size which is insufficient to carry the current used. If the size or type of the carbons employed have been changed before this trouble was noted, be sure that the change was made correctly, for the wrong size may now be in use. This trouble may also be due to the use of cheap grades of carbons of unequal capacities.

(b)—Defective carbons are a frequent cause of this trouble. In cored carbons the core may be defective or even absent.

(c)—Loosened strands in a lead may be touching intermittently due to vibration, thus causing a brief, intermittent shorting or grounding of part of the current. Examine all leads and remedy them wherever necessary.

6. Arc Unsteady, With H. I. Lamp

(a)—The current used may be excessive. This should be tested and reduced to the proper value

for the size and rating of the lamp and for the type of carbons employed.

(b)—The carbons may not have been properly lined up with one another. Make a correct alignment, and if the trouble disappears, maintain the new alignment.

(c)—The ventilation may be incorrect thereby permitting strong drafts to act on the crater. Improperly designed lamphouses can bring about this condition if the door is open or if the independent vents in the housing have been cut.

(d)—The positive carbon may not have been set to project sufficiently out of the heat shield. Set the carbon forward slightly, and if the condition disappears the trouble can be avoided in the future.

Warning: Do not set the carbon too far forward as this causes it to burn excessively and will reduce its life considerably.

(e)—The connections and contacts may be just loose enough to make a good contact, but with a bit of vibration to decrease contact. Examine all current-carrying contacts, also the screws, nuts, and springs controlling them and correct the deficiencies in steadiness or in good contact.

Note: In those types of H.I. lamp where part of the current passes through the negative carbon from the holder end and the balance of the current

passes through a "V" rest, be sure this rest is cleaned regularly and is kept free from scale, corrosion, and dirt. Much trouble can be avoided by constant attention to this rest as well as to the contact at the butt of the carbon.

7. A.C. Arc Very Noisy

(a)—Poor quality or wrong size carbons are being employed, therefore change to better quality special A.C. carbons of the size recommended by the lamp maker. When an emergency change, from D.C. to A.C., is effected, the resultant noise, while completing the run of film already in the projector, cannot be helped.

8. Arc Flames Badly and Burns in a Puffy Manner

(a)—The negative carbon has turned positive through the switching, at the power station, to a machine of different polarity. If no polarity-changing switch is included in your circuit, watch the carbons when the arc is killed:—the carbon that remains red the longest is the positive one at that time. If it turns out to be the lower one, reverse the leads.

(b)—This trouble may also be due to a carbon with core binder not holding, thereby permitting the core to blow out as a powder. Throw away the rest of the carbon and burn in a new trim.

9. Arc Fluctuates, Although Carbons are Right and Contacts Clean and Tight

(a)—Examine the generator. A dirty generator commutator or dirty brushes may bring about this condition. For the correction of such trouble look under section headed *Motors and Motor Generators.*

10. Arc Unstable, Even Goes Out, With Reflector Arc Lamps

(a)—This may be due to poor ventilation, for this type is most sensitive to strong drafts or sudden currents of air. Avoid trouble by seeing that no ventilating fan, etc., forces cold air or a strong draft upon the arc.

11. Arc Amperage Excessive When Arc is Struck, Becomes Normal After Arc Burns Awhile

(a)—This is due probably to a rheostat having cast iron grids. If the rheostats are of a large size they have the property of passing the current more freely when cold than when heated at which point their resistance is increased to the value at which they are rated. More ballast resistance may be required during the "cold period" and, possibly, the ballast being used is out of circuit. Examine and correct it if the condition is likely to cause further trouble.

LIGHT SOURCE

Carbon Troubles

General Trouble with Oldstyle Arcs

1. Crater "Wanders" About

(a)—This may be due to the fact that the wrong type of carbon is being used. If a solid upper carbon is used, it has no core with which to make an easy path for the current to pass through and with which to hold the current to one path. If solid positives are being employed, change to cored positives.

(b)—The negative carbon may, probably, be too large for the positive. If a large negative, that holds a blunt point, is employed because it is cheaper, try a smaller metal coated negative and be sure the carbons are set in proper alignment. The lower carbon must not be centered directly underneath the positive, but slightly in advance of it to form a crater at a suitable angle.

2. Carbons Have Very Short Life

(a)—Carbons are being employed which are

too small for the current used, thus being overloading. Use only the size recommended for the lamp employed.

(b)—If the size and type of carbon recommended for the current is employed, it is possible that the ammeter is out of order, giving a low reading which has deceived you into boosting the current value beyond the capacity of the carbon. Have the meter checked.

3. Short Carbon Life With H. I.

(a)—The positive carbon is protruding too far forward and therefore burns excessively. Adjust the carbon so as to prevent sputtering and unsteadiness and also to reduce the carbon consumption to a minimum.

4. Crater Area Too Small

(a)—Excessive needling is due to continual overloading. Check the meter if the area has decreased and the spindling has increased, for, due to meter inaccuracy, an excessive current is perhaps being employed unintentionally. If this is the trouble, reduce the current.

(b)—This may also be due to a bad electrical contact, especially so in H.I. lamps of that type in which the current passes both through the carbon length through the holder, and through a "V" rest.

Inspect this first, and note if the rest is clean and free from corrosion and resistance-making dirt. Note also if the springs and the weight holding the carbon in contact with the rest, work properly. If not, correct them.

5. Carbon Needles, Spindles, and Pencils

(a)—This may be due to the use of too small a positive, which induces a quick consumption of the materials, a possible blown out core, or a burning away of the tip into the forms mentioned in the heading. Change the size of the carbon.

(b)—According to the style of the lamp employed, the following may be the causes of this trouble:—a poor contact between the carbon and the holder, a poor contact between the carbon and the clamp, or a poor contact between the carbon and the contact shoes. The heat thus induced adds to the carbon heat and tends to burn away the materials very quickly.

(c)—In a negative carbon this trouble is due to the fact that the carbon is too small for the current employed; or, as with the reduction of the crater mentioned above, in the H.I. type lamp it is due to poor care of the rest through which part of the current is fed into the carbon. Dirt or an improper contact will also compel the carbon to carry the current through its whole length, heat up, and

finally, to pencil. Check up and remedy these faults. Some projectionists clean the H.I. type lamp contact after every few reels, especially that type which has a "V" rest. If the negative metal coating is too thin, it will also cause needling.

6. Carbon Shattered by Striking Arc

(a)—This may be due to the fact that the carbons are not separated quickly enough when striking the arc. This must be done instantaneously or else the carbons may have their points "graphited" or shattered.

(b)—Striking the carbons together too hard is another common cause for this trouble.

7. Carbon Develops Mushroom (Button), Point

Also Known as "Freezing of Arc"

(a)—Too short an arc is being maintained. The changing of the carbons will not help, but the increasing of the arc length slightly will remedy this trouble.

8. Carbon Core Burns Away, Recesses

(a)—Current is too low for the size of the positive in use. Increase the current slightly and see if the condition does not improve; or use a smaller carbon if the current is limited to the value in use.

9. Carbon Core Blows Out

(a)—The current is too heavy, therefore the cored carbon is overloaded. Try a reduction of the current and if the difficulty is ended, have your meter checked to make sure you have not increased the current unknowingly through a faulty reading of the meter. Also may be caused by defective core of poor manufacture.

10. Carbons Cause Sputtering, Hissing

(a)—This may be due to dampness in the carbons. The best way to avoid this trouble is to have one or more trims in preparation in a suitable place, such as against the lamphouse or over the rheostat, in order that they will be thoroughly dried.

11. Carbon Burns with Lip or Over-hang

(a)—The negative carbon, in all probability, is too far forward. Readjust the alignment until the crater is correct for the best light. Also, the positive carbon may not be revolving.

12. Carbon "Lips" When Using Reflector Arc

(a)—If the lip is on the lower side and is wasting the light upward, the negative carbon is set too high and therefore requires a slight adjustment

downward until it burns into a blunt-nosed crater form which directs most of the light to where it will be most useful.

(b)—If the lip is on top with the angle sloping downward and backward, and the light is wasted downward, the negative carbon must be readjusted a bit higher in order to obtain the best results.

LIGHT SOURCE

Filament Lamps

1. Bulb Looks Blackened

(a)—Filament evaporation turns all such bulbs slightly dark, but the construction is such that most of the blackening is above the light diverging range. Therefore, if the lamp gives satisfactory illumination, the blackening can be disregarded.

2. Dark Spot Shows in Filament Coils

(a)—This may be due to a short circuit caused by the coils touching each other. No correction, other than the installation of a new lamp, is possible for this trouble.

3. Lamps Have Very Short Life

(a)—In an attempt to obtain more screen brilliancy the lamps are overloaded. The rated current of the lamp must not be exceeded. A new or brighter screen surface will help reduce the need for overloading.

(b)—A faulty meter may be causing overloading through erroneous readings. Have the meter checked regularly.

4. Mirror Images Do Not Fall Exactly Between Filament Images

(a)—This trouble may show up when a new lamp is installed. In this case it may be due to a slight difference in the assembling of the coils during manufacture, and must be compensated for by a slight alteration of the mirror.

(b)—The new lamp may not have been installed according to the maker's instructions, which should be followed carefully for best results.

(c)—The mirror adjustment may have loosened slightly, or may have been moved inadvertently. Do not alter the lamp at all if it has been set according to the maker's instructions, but adjust the mirror slightly until the images coincide—being very careful, however, to make the changes very slight at each adjustment.

5. Lamp is Blown Out When Projector Table Switch is Pulled

(a)—If the controller handle is left at "On," then the pulling of the table switch will blow out the lamp. Always follow the proper method for putting the current "On" and "Off" when using incandescent lamps.

LENSES

Optical Train

1. Condenser Breakage Excessive

(a)—This trouble may be due to the fact that the mount clutches the edge of the lens too tightly or to the fact that the mount does not expand with but contracts faster than the glass. This can be remedied only by obtaining a more modern type of condenser mount or one made by a reputable maker.

(b)—The condenser is placed too close to the arc, thereby overheating it and then straining it in cooling. Locate the arc further from the condenser.

(c)—The flaming of the arc overheats the lamphouse. Keep the ventilating flue and its screen clean and free for the passage of air.

(d)—Poor ventilation with an excessive arc heat will bring the lamphouse temperature to a point where the condenser breakage will be very high. If good ventilation is provided, clean the flue regularly and prevent trouble.

(e)—Too sudden cooling of hot condensers will also cause this trouble. Cool air on a hot mount

will contract the mount more rapidly than the glass. Handling the hot glass may expose it to a sudden cooling and an uneven stress. Avoid all such conditions.

(f)—This trouble may also be due to poor, cheap glass in cheap lenses which are unable to stand any strain.

2. Condensers Become Discolored

(a)—This is due to the chemicalization of the ingredients in certain types of glass. If the make in use discolors considerably, change to another brand. By looking through the edge of the lens, when selecting it, any discoloration can be detected. Reject any discolored lenses, especially if of a greenish hue, since this tint is apt to interfere with color film projection and will, in general, give an unpleasant tone to the screen light.

3. Condensers Pit Badly

(a)—Some makes of coated carbons have a greater tendency to pit condensers than others. If the crater distance cannot be altered or the use of metallic coated carbons discontinued, try another brand or make of coated negatives.

4. Lenses Seem Streaky

(a)—This is, probably, due to oil or dirt. Clean the surfaces with a half-and-half solution of water

and alcohol and polish them while they are still wet. Use only a clean, very soft, and lint-free cloth.

(b)—The Canada Balsam used to cement the elements may have melted, in which case return the combination to the manufacturer for correction or replacement.

5. Rear Element Retaining Ring Binds When Element is Removed for Cleaning

(a)—The ring may have been bent or damaged by careless contact with some part of the mechanism of the projector. Examine for the damage and delay the removal until ample time and care can be used.

(b)—Perhaps too much pressure is being applied to the sides of the ring. If the ring is not damaged, pressing lightly with the fingers on the two sides is sufficient to make it yield and release.

MERCURY ARC RECTIFIER

1. Rectifier Does Not Work On Starting-Up

(a)—The fuses, which should be tested first, may be blown out. Replace them, if necessary.

(b)—The supply line voltage may be off. Test for current at the rectifier tube, and if none is found there, test for current on the line side of the switch. Be sure that all the switches in the circuit are closed.

(c)—The circuit may be open. If the fuses are intact, the switches are closed, and the line voltage is correct, note if all the contacts are tight. Note especially if the electrodes of the tube make the proper contacts.

(d)—The tube may be dead. Examine it, and if the tube is badly blackened, it is probably short-circuited between starting anode and cathode. Try a spare tube.

Note: The mercury in the tube should produce a sharp, crackling sound when it is allowed to roll about gently in the tube. If a dull sound is heard, it is best to put this tube aside and use another.

(e)—The tube does not tilt. Electrical rectification is not established. Look under the following heading.

2. Tube Does Not Tilt

(a)—Friction is binding the tube. Test it by tilting it with the hand. If the tube binds, tilt it carefully and eliminate friction in the device.

(b)—The tilting relay may not be making a contact. In this case look for the following:

1. Friction in the tilting relay. Find the friction and eliminate it.
2. Dirt, or some other obstruction prevents a contact. Remove the obstructions.
3. A bent stud may be the cause. Correct it if found.
4. The contact arm may be jammed. Straighten or loosen it.
5. The wire or the contact may be loose or broken.
6. The secondary coil of the magnet may be short-circuited. Test, repair, and replace it.

3. When Tilted By Hand, Tube Does Not Start; When Tilted By Shaking Magnet, Tube Does Not Tilt

(a)—There probably is no current at the tube

terminals. Note if the contacts have become loose or broken. Locate the condition and correct it.

(b) The amalgam bridge between the terminals may have ruined the tube. Try a spare tube.

(c) The lamp circuit may be open. Note that all the switches are closed, and that the carbons are brought into proper condition for starting the device.

(d)—The carbons may be making insufficient or no contacts at the tips, and poor or no contacts with the jaws or the clamps. Remedy this if it is discovered to be the cause.

(e)—If none of the foregoing locate the trouble, and the spare tube does not operate when tilted, rock the tube by hand. Note if the pools of mercury make a contact, and if not, adjust the tube until they do so.

4. Tube Lights But Goes Out

(a)—The lamp carbons, probably, have been pulled too far apart. Re-establish a contact and bring them closer together when the tube lights.

(b)—There may be a poor vacuum in the tube. Try a spare tube, and if the trouble ends, discard the old tube.

5. Tube is Tilted by Shaking Magnet, But Does Not Return to Vertical Position

(a)—There may be a loose or broken lead to the starting anode. Test the lead.

(b)—Friction may be holding the tube. Test for friction, and remedy the condition.

(c)—The tube mechanism may be tilting the tube too far for it to return to the vertical position. Set it so that the mercury pools make a contact but so that the tube will return to vertical. If the action appears sluggish, check again for friction in the mechanism.

(d)—The mechanism may not be tilting the tube far enough. Note this and correct it.

6. Tube Tilts and Returns, but Does Not Flash

(a)—If repeated tilting produces no result, the tube is defective or has lost its vacuum; therefore, a new tube is required. Note if any air bubbles are present within the old tube:—if so, it is proof that the vacuum is destroyed.

7. Tube Tilts, Flashes, Then Goes Out

(a)—The lead to the positive anode is probably loose or broken. Test it, then tighten, and clean or replace it.

8. Tube Tilts Feebly

(a)—This may be due to a low circuit voltage. Check the voltage.

(b)—An incorrect current frequency will also cause this. Test this frequency and be sure it is correct when the installations are made.

(c)—The tube is out of balance for it may be too heavy at the lower end. Readjust the balance.

(d)—Friction in the tilting device is another common cause. Check the device and remedy it if necessary.

9. Tube Lights and Keeps on Tilting

(a)—The relay that opens the tilting circuit does not work. Examine it and if it does not operate, check for the following.

1. The winding may be short-circuited.
2. Friction or lodged dirt may be preventing its operation.
3. A bent part or damaged spring may be preventing its movement.

10. Device is Very Noisy

(a)—The floor may be vibrating with the device. Test its solidity and insulate the device by setting it on sound-absorbing pads, or move it to another location.

(b)—A magnetic action may be setting up between the transformer of the device and some nearby sheet metal.

(c)—The cover of the mechanism may be loose or vibrating. Close the cover and tighten it.

(d)—The reactance coil may be loose on the frame. Adjust it more solidly.

(e)—The reactance coil airgap may not be wedged tightly. Note this and remedy it if necessary.

Warning: When first putting the mercury arc rectifier into operation be sure the potential relay operates or else the limiting resistance will overheat and may damage the insulation on the wires and injure itself, even though it is not apt to burn out.

Emergency Measure: If no replacement tube is on hand or if the rectifier fails to work entirely, cut it out of the circuit and shift to A.C.

CAUTION: *Do Not Fail* to disconnect the D.C. arc controller motors when shifting over to A.C.

For Screen Trouble when shifting to A.C., look under heading *Picture.*

MOTORS AND MOTOR GENERATORS

Troubles Noticed During Inspection

1. Undue Wear and Other Damages are Evident

(a)—This may be due to a lack of proper care and the failure to keep the device clean and properly oiled with the correct qualities and grades of lubricants.

Note: Inspect the mechanism daily and correct the troubles when they start. Keep everything clean and free from dust and watch the oil drip. Use the oils which the manufacturer recommends and oil plentifully but not overly for excessive oiling can do much damage.

(b)—A wrong location, such as in a damp cellar which permits moisture to be absorbed and expelled rapidly when the motor heats, is another common cause of trouble. It causes straining and an eventual damaging of the insulation and the coils. Dust, dirt, and ashes circulate and settle on the parts, and the dampness holds them and causes

abrasion and undue wear. Do not locate the motors where dust, ashes, moisture, or constant dampness exist.

(c)—The following are some further causes of undue wear:—excessive vibration, due to an improper base; poor pad insulation against vibration, and loose bolts to the bed or frame. These conditions should be corrected if found.

(d)—In upright types, if the oil is too freely used it will spread from the bearings and will collect and hold dust and dirt. It will also foul the commutator, etc. Avoid an excess of oil and of thin or cheap oils without body enough to remain in the wells or cups.

(e)—The voltage, the cycle, and the phase are not correct for those of the supply source. Note the data on the nameplate and check with the supply. If they do not agree, remedy them at once, for while the motor may be operating under adverse conditions, it is not delivering what it was designed to deliver and is possibly being subjected to a serious risk of damage from overloading or other faults.

(f)—The assembly of the units, or the position of the units and the base, is not level. If they are not strictly level there is a great wear on the bearings, commutator, etc. A test should be made on horizontal devices for a slight floating of the armature; and if this is absent, it is very probable that the assem-

bly is not in true horizontal balance. Test the assembly with a spirit level at various points of the base and the units. In the case of upright types, test them with a spirit level, because if they are not strictly upright there is apt to be undue wear on parts of the device which would be costly to replace.

(g)—The drive element and the generating unit if they are not integral on one shaft, may be out of alignment. Test the level of the base and the joining of the elements in whatever type of connection exists. If the connection is badly worn, it is probably due to incorrect alignment, off-level, etc.

(h)—The material provided to absorb the vibration may have settled more at one end (the heavier end of device), than at the other, and the bolts may have come loose. Excess vibration, from any cause, is sure to wear out motors and motor generators rapidly. Test for correct level while the device is not in operation; and for excessive vibration, while it is in operation.

2. Coils and Windings, Especially Around Commutator, Seem Damaged. Weakened Insulation is Visible

(a)—Two common reasons for this trouble are careless cleaning and the use of benzine, gasoline, and similar products for cleaning the commutator. Such cleansers cannot be prevented from running

down the parts, cutting the shellac, and softening the insulation which, in time, can cause serious damage. Therefore, these or similar products are *never* to be used. To clean the commutator, prepare a canvas pad in which a small quantity of clear vaseline has been allowed to penetrate. Wipe off the dirt, dust, etc., with a rag, then brush with a bristle brush not hard enough to abrade or wear, but just stiff enough to remove the dirt and the brush-dust from around the commutator, the bars, and the springs. The commutator should then be wiped with the pad, but not much vaseline should be allowed to get upon it. Soft brushes usually have enough paraffin in them for commutator lubrication.

BEARINGS

1. Ball Bearings are Roughened or Completely Ruined

(a)—An incorrect type of lubricant is being used. Any oil which contains acid will, in time, roughen or possibly ruin the bearings. Use only that oil which the maker recommends.

2. Bearings Show Undue Wear

(a)—This may be due to the uneven installation of the set. Test the balance and correct it, if necessary.

(b)—Dust, dirt, and ashes from the furnace are allowed to get into the bearings. This should be prevented.

(c)—The oil rings may be sticking or rotating intermittently. Look at the rings and see that they revolve freely and that the oil is at a level where they can dip up and carry it to the bearings.

3. Bearings are Grooved

(a)—Due to the possible incorrect leveling of the set, there may be no "float" to the armature;

or, if it is a two-element assembly, the elements may be forced too close together, thus causing the shafts to prevent armature "float" or play. If the armature does not show a slight end-play or "float," check it very carefully and remedy the trouble.

4. Brushes Wear Excessively

(a)—Too much pressure is being applied to the brushes, or the springs may be set too tightly. Use just enough tension to make a perfect electrical contact, but not so much that it grinds the brushes against the surfaces with which they come into contact.

(b)—The brushes may not have been set correctly, that is, not at the point of the least sparking or no sparking. Test this and see if the brushes have been changed from the setting which agrees with the manufacturer's marking located at the end of the bracket or at some other point. If the brushes are out of their correct positions readjust them immediately.

5. Brushes Stick in Holders

(a)—There may be some dirt either on the brush or on the holder. The brush should not be loose enough to "jiggle," but it should have just a bit of free movement in the holder.

(b)—The brush may not be "true." If this condition is discovered, the brush should be discarded unless the sides can be trued-up with fine sandpaper.

(c)—If the hammer-tension method is used, it may not be resting solidly or truely. This should be tested and corrected, if this fault is found to exist.

6. Brushes Make Poor Contact

(a)—The surface of the commutator may be roughened. Inspect the commutator and then look under section headed *Commutator.*

(b)—The brush may have become loosened and may have swung off, thereby wearing unevenly. Before making a new contact be sure that the brush neither sticks, jams, nor plays too freely. Then, take a piece of fine sandpaper, place it with its face toward the brush and away from the commutator, allowing the brush to rest on the sandpaper, and move the commutator back and forth, thereby grinding down the brush. Finish off with a still finer sandpaper by moving the commutator in the direction in which it usually rotates, until a perfect contact is assured.

Warning: Never use emery or other hard grinding mediums on motors or generators or their

parts. Be sure to clean the parts carefully after using the sandpaper and thus avoid scoring the surface of the commutator.

7. "Bucking"

Arcing Between Adjacent Brush Arms

(a)—Water may have gotten on the commutator. Dry the commutator and wipe it clean.

(b)—There may be an extremely low commutator surface resistance, due to a dirty or roughened commutator, between the brushes of opposite polarity. Smooth the surface carefully and keep it clean.

(c)—There may be an excessive voltage between the commutator bars due to short circuits. This voltage may be causing overloads. Test for short circuits and eliminate them if they are found.

STARTING TROUBLES

1. Device Fails to Start When Proper Starting Instructions are Followed

(a)—There may be no current in the line. Test for this and note if the main line fuses are blown. Also, note if the fuses in the circuit are intact. If the fuses are intact, test the line voltage. If no voltage is evident, the supply generator has undoubtedly failed. There is no remedy for this unless an emergency supply arrangement is at hand.

(b)—This may also be due to broken contacts, bad wiring, and very dirty contacts. These should be examined, cleaned, and tightened wherever necessary. Examine the wire ends or the coils exposed to rubbing or movement for breaks and remedy them if found.

(c)—There may be a short-circuit in the set wiring. Test for this, locate it and then eliminate it.

(d)—The leads may have been replaced wrongly after cleaning. This should be tested and corrected.

(e)—If a second-hand set, which has just been installed, is being used, a wrong wiring circuit may have been employed. Cut off the current and go over the wiring very carefully. If the wiring is correct, inspect the set for damage in shipping, delivery, or installation.

2. Set Operates But Does Not Attain Full Speed

(a)—Note if the starting is marked by heavy sparking. If found so, there is apt to be a serious ground which is causing a heavy overload on the motor. Test for this, locate it, and then eliminate it.

(b)—A bearing which is not lubricated may be binding. A ring may have become stuck, or no oil is reaching the bearing. Examine this, and correct it at once.

(c)—There may be a low supply line voltage, or wrong cycles.

(d)—The fuses of one phase may be blown out, or perhaps there are wrong connections to the motor.

3. Motor Revolves in Wrong Direction

(a)—It may not be in step with the phases of the current used. (Look under the individual make headings for the proper rotation and method of phase-changing.)

(b)—G.E. Compensarc, Polyphase. The motor should revolve clockwise when viewed from the motor-generator end of the set. The following are the methods for changing the revolving direction of the motor:

1. In a two-phase, four-wire motor:—the connection of two leads of one of the phases should be changed.
2. In a two-phase, three-wire motor:—disconnect one phase-winding from the "common" jumper, and connect the other end of the same phase-winding to the "common" jumper. Then, connect to the line that end which you first disconnected.
3. In a three-phase motor:—reverse the connections of any two of the wires.
4. In a single-phase motor such as Type AR:—in these the direction of rotation is controlled by the position of the brushes, and it is indicated by the scale on the rocker ring and the pointer on the front of the bearing bracket. The scale has three lines which are marked, in this case, RR, N, and RL. When the pointer is opposite RR, the motor rotates clockwise; when it is opposite RL,

it rotates counter-clockwise; and when it is opposite N, no rotation can be secured, for this is the neutral point.

4. Set Does Not Pick Up Readily

(a)—A weak field, which is possibly due to a short-circuit in the field coils, may be the cause. Make a test with a voltmeter and if all read alike, look under the following:

(b)—The weak field may be due to a loose joint in the magnetic field. Inspect this and remedy or repair it.

(c)—Heat may have lowered the insulation properties of the field windings, thereby allowing the current to short-circuit. A replacement is the only recourse in this case.

5. Set Does Not Deliver Full Voltage

(a)—This may be due to a low motor speed. Correct the condition causing it.

(b)—This may also be due to a defective commutator. Look under *Commutator.*

(c)—Poor quality or dirty brushes may be the cause. Use correct brushes for the set.

(d)—A weak tension on the brushes is apt to cause this. Test this and correct it, if necessary.

(e)—Loose "pigtails" will also cause this trouble. They should be examined and corrected, if found faulty.

(f)—A common cause for this trouble is a loose or corroded connection in the wiring. Inspect this and remedy it.

OPERATION OF SET

1. Set Loses Original Efficiency

(a)—Inefficient operation of the set is due to the following:

1. Failure to keep the set scrupulously clean and free from grit, dirt, and oil.
2. The set is not being kept strictly level.
3. The bearings may be off-level and, due to a lack of oil, may be badly worn.
4. The commutator is damaged. If so, look under the heading, *Commutator.*
5. The field coils are weakened. Look under heading, *Starting Troubles, section 4.*
6. Continuous overloading, due to the set being too small for the demands of the projection light and to the use of more current at a higher voltage than that formerly employed. This overloading may be unintentional, being the result of incorrect meter readings. Check these readings.

7. The set is allowed to overheat. The causes of this will be found under the heading, *Overheating.*

8. Poor oil, into which dirt has been allowed to enter, has been used. The rings on the bearings have been allowed to dry or have been dipped into oil which has lost its lubricating body.

2. Set is Noisy

(a)—This may be due to loose bolting to the absorbing pads, and loose boards under the pads or under the motor generator set. Tighten these bolts and keep the set level.

(b)—The bearings may be defective or have been improperly installed. Examine them and note if they run free and without vibration or play.

(c)—The set may not be level thereby putting its elements out of alignment. Test the level.

(d)—Loose bearings will also cause noisy operation. Note whether they are loose in the housing or on the shaft and take the necessary steps for correction.

(e)—This may also be due to a sprung shaft. This trouble calls for a replacement, unless the shaft can be trued.

(f)—The armature is out of balance. If this happens, the safest method of correction is to notify a service man.

(g)—The air gap around the motor rotor may not be even all around. In the case of two-bearing sets, where nuts hold the motor and the bracket, adjustment may be made by loosening the nuts and, with a feeler gauge, used around the rotor, gently adjust the rotor until the air gap is equal all the way around. Then slowly tighten the nuts.

3. Unusually Severe Vibration

(a)—The bolts holding the elements to the base are loose. They should be tightened.

(b)—*Look at preceding heading No. 2, under sections (b) to (f).*

4. Motor Does Not Deliver Desired Amperage

(a)—See that the voltage is correctly adjusted, and if ballast resistance is used, adjust the ballast resistance to raise or lower the amperage. If this fails to correct the trouble, inspect the set for mechanical defects and look for the remedies under the proper trouble headings.

5. Motor Does Not Deliver Desired Voltage

(a)—This may be due to a faulty commutator. Inspect this and correct or repair it.

(b)—Dirty brushes or a dirty holder will also cause this trouble.

(c)—See whether the brushes are of the correct make and size. If not, change them.

(d)—Insufficient brush tension is a common cause. This should be tightened a trifle until a perfect contact is obtained.

(e)—Loose "pigtails" will also cause this. Inspect them and, if necessary, remedy them.

(f)—Corroded or loose connections may be the reason. Inspect these and clean or tighten them.

(g)—The meter may not be reading correctly, although the set may be correct. If a superficial inspection shows nothing seriously wrong, check the meter before the set is condemned.

6. Characteristics of Set Change When New Brushes are Installed

(a)—The new surfaces are not making a proper contact. Do not make a connection with springs for the carrying of the current, for springs may be burned-out.

7. Whole Set Seems to Overheat

(a)—First, be sure that the set actually is overheated, for a temperature which is too high for the hand to bear, especially in the summer, may not

be beyond the safety allowance. The highest permissible temperature is 194° Fahrenheit. In order to test the temperature, use a thermometer which has its bulb encased in putty. Allow the putty to remain in contact with the motor until it has attained the full motor temperature and until the heat has penetrated the putty. The reading will then be close to accurate. If the temperature is 194° Fahrenheit, or above, look for trouble.

(b)—In all probability the set is constantly being overloaded. Reduce this overload.

(c)—If a Westinghouse series arc equipment is being used, be sure to keep both short-circuiting switches closed when idling, or else the field coils will become overheated.

(d)—If a 110-volt motor is employed, it may be on the 220-volt wires of the three-wire system. Check this and change it if found at fault. The same applies to that case in which a 110-volt line is being used for a 220-volt motor.

ARMATURE TROUBLES

1. Armature Overheats

(a)—The device is continuously overloaded. Reduce the load and have the meters checked if they give normal load readings when this trouble is apparent.

2. Armature "Wabbles"

(a)—This may be due to a bent armature shaft. It is the safest to replace this part, having the service man attend to the removal and to the change.

3. Armature Heats Up Suddenly

(a)—This may be due to a partial "short" in the coils. Test the coils and remedy them, if necessary.

(b)—There may be a short-circuit or a ground in the armature coil windings or in the armature. Test for this and, if possible, eliminate it.

(c)—The connections offer a high resistance. Test and clean them, and note if any connection has been abraded or worn so that only a strand or two makes a good contact. Remove all corrosion or dirt, and note especially if any oil is evident.

BALL BEARINGS

1. Ball Bearings Leak Oil

(a)—The grease used is too thin. Use only proper bodied lubricants.

(b)—The grease has been used too plentifully and therefore is being forced out. Use only a proper amount.

(c)—The housing or the bearing are too hot, thereby thinning the lubricant. Test this, and if found hot, drain it, flush the housing, and use fresh lubricant.

2. Sleeve Bearings Leak Oil

(a)—The bearing is badly worn. Inspect it, and if the wear cannot be taken up, replace it.

(b)—The drain hole on the inside end of the bearing is clogged. This should be inspected and cleared.

(c)—The oil well is filled too full. Remove some of the oil and watch the level more carefully in the future.

(d)—If the overflow cover sticks down, it should be loosened.

(e)—The overflow hole of the well is clogged and should be cleaned.

(f)—Readjust the oil ring if it has slipped from under the retaining pin.

(g)—A sand hole may have developed in the bearing house. Inspect this and remedy it.

3. Sleeve Bearings Heat-Up

(a)—This may be due to the use of poor oil. Change the brand of oil.

(b)—If the sleeve bearings lack oil, they will heat-up, therefore increase the supply and oil them more frequently.

(c)—The body of the oil is destroyed because of long use. Change the oil frequently.

(d)—The oil rings may not be revolving or they may be binding, due to the fact that the set is off-level. Examine the rings and correct them, if necessary.

4. Ball Bearings Run Noisily and Show Wear

(a)—Not enough grease is being used. Provide more lubricant.

(b)—The grease employed may be too heavy. Try a lighter grade, although one not so light that it will run out.

(c)—The grease has been kept in the housing too long, or dirty grease has been allowed to get into the bearings. Flush the housing occasionally and refill it with clean grease.

(d)—The acid in the grease eats into and roughens the race and the balls. Use a non-acid lubricant.

(e)—Inspect the balls for flat spots. Replace them if these spots are found.

5. Waste Packed Bearings Heat-Up

(a)—A new packing is needed.

(b)—The packing may not have been placed around the journal properly. Pack this carefully.

(c)—Poor oil, dirt, etc., may be the reason.

COMMUTATOR TROUBLES

1. Commutator Bars Are Short-Circuited

(a)—Failure to keep carbon dust cleared away and over-lubrication of the commutator which allow the space to fill with combined dust and oil, are a common cause of short-circuiting. Clean and avoid serious trouble through short-circuiting, overheating, arcing, sparking, etc.

2. Commutator Overheats

(a)—This may be due to sparking. Look under section headed, *Sparking.*

(b)—Constant overloading will also cause this, therefore it is necessary to reduce the overload.

(c)—The brush pressure may be too great. Adjust the tension.

3. Commutator is Grooved

(a)—The brushes are too hard. In this case it is best to follow the maker's recommendations for correction.

(b)—The brushes may be of a cheap make and

probably contain grit. Use only brushes which are of the best grade.

(c)—There may be no "float" to the armature, therefore be sure that it has a trifle of end play.

4. Commutator is Cut and Rough

(a)—This may be due to too much brush tension. This condition should be corrected if found.

(b)—Dirty brush faces and cheap brushes will also cause this trouble. Clean them or change their quality.

(c)—The lack of armature "float" or end play is another reason for this trouble. This can be corrected by leveling the set.

(d)—The brushes may be off their correct setting. Readjust them according to the markings.

(e)—The brushes are jammed in the holders thereby causing a metallic brush scraping.

(f)—The brushes are worn down and are too short, causing the metal of the spring or other pressure device to make contact with the commutator. The brushes should be replaced more often.

(g)—This trouble may also be due to hard brushes which have a gritty surface or to a piece of metal between the brush face and the commutator.

(h)—The commutator may be out of "true," and should therefore be tested for roundness and "trueness." Although this work must be done very carefully, it is possible for a good machinist to turn down the commutator and save replacement.

5. Commutator Shows Ring of Fire All Around

(a)—Look under section headed, *Sparking,* page 89.

FIELD COILS

1. Field Coils Overheat

(a)—There may be an overload. Check the meters and reduce the load if it is continually too great.

(b)—The brushes are incorrectly set, therefore they should be readjusted.

(c)—The coil may be partially short-circuited. Test for this short-circuit and eliminate it if it is found.

SPARKING

(a)—The brushes are worn down too far, which will damage the commutator.

(b)—The brushes may not be set at the point of least sparking. Note the manufacturer's mark and readjust the brushes to it. If an old-style generator which has no markings is in use, move the brushes to a point where the sparking either disappears or is at a minimum.

(c)—If a two-pole is employed, the brushes are not arranged exactly opposite each other. If a four-pole is employed, the brushes may not be equidistant. Adjust the brushes until the sparking ceases and they are equally spaced.

(d)—If a belt drive is employed, note if the belt slips, for the slipping of the belt will cause sparking. Tighten the belt or apply a non-slip dressing.

(e)—Dirty brushes and a dirty commutator are also causes of sparking. Clean and adjust the contact and wipe the commutator, but do not scrape or scratch it.

(f)—The following are some very common reasons for sparking:—poor contact; a weak tension spring; poor "pigtail" contact; brush sticks in its holder; brush is at a wrong angle; brush is not rounded to the commutator; the insulation of one of the bars is too high. The remedies for these are obvious.

(g)—Loss of temper in the tension spring prevents it from making the tension strong enough. See if it is carrying more than its share of the current. If the tension spring seems overheated, provide some form of a jumper to help carry the current. This should be done when installing the next spring, unless a larger size or a heavier wire can be installed in the holder.

(h)—The commutator may be worn thin. If it is, it will be necessary to replace it with a new one.

(i)—The commutator mica segment is either too high or too low. Note if a click is heard as the brush is met. Locate the offending member, and while it is safest to send it away for correction, if the segment is high you may be able to readjust it by placing a small block of wood upon it and lightly tapping the wood with a hammer.

(j)—The commutator may be roughened badly. If the fault lies in the materials, return it to the maker. If it is due to careless brush tension, inattention to the leveling of the set, etc., correct it as

best you can until its condition compels replacement.

(k)—Sparking may also be due to high resistance in the brushes. If they overheat and crumble get a better quality or a different grade and always follow the maker's instructions.

(l)—Worn, low bearings will allow the armature to be out of horizontal, or out of vertical, according to the type of set employed. Note if the air-gap is equal and even all around, between the rotor and the stator. If this fault cannot be corrected, replace the bearings.

(m)—The armature coil may be short-circuited. Obvious signs of this trouble are a badly fluctuating voltmeter and a hot coil. Locate and remove the short-circuit.

(n)—An armature coil may be reversed. This should be tested by holding a magnetic compass over the coils and noting if one deflects it opposite to the direction the others deflect it. When making the test have the brushes raised and use battery current. The coil which alters the compass direction opposite to that of its mates, must be reversed.

(o)—The armature shaft may be bent. Note its steadiness of torque and see if it binds. The repair or replacement of this part is a very delicate job and expert advice should be solicited.

(p)—A continuous, sustained overload will also cause this trouble. Check the meters if they seem to be reading normally, although the trouble develops and continues.

(q)—Running the motor at an excessive speed will cause sparking, therefore the speed should be reduced.

(r)—This may also be due to a weak field. Look under heading, *Starting Troubles, section 4 (Set Does Not Pick Up Readily).*

(s)—A shaky floor and loose bolts to the bed or the base, which permit considerable vibration, can assume proportions sufficient to cause sparking. Test these parts and correct them if necessary.

(t)—If a ring of fire is visible around the commutator it is probably due to a neglect of cleaning. In this case a compound of oil, brush carbon, and dirt has, undoubtedly, bridged itself between two adjacent commutator bars. Stop the set and clean it.

(u)—A bit of metal dragging across the bars. Examine the parts closely before looking any further.

(v)—A broken wire in the coil or a break in the connection leading from the armature to the commutator. This break in the connection is due to its being burnt off by excessive currents.

(w)—A loosened commutator may have snapped a lead. Examine the connection and, if possible, replace it. Since this is a delicate job it is desirable to have a service man do it.

VOLTAGE

1. Voltage Fluctuates Badly

(a)—This is probably due to a short-circuited armature coil. Test for the cause, and if found, remove it.

(b)—This is possibly due to a loose connection between the drive motor and the generator in that type of set in which the elements are connected by joined shafts. Where adjustment is provided, examine the parts and take steps to remedy the slipping.

2. Voltage Does Not Build Up As It Should When Set Is Started

(a)—The line voltage may be slow, thereby giving slow speed results. The line voltage should be tested.

(b)—If the motor is short-circuited, it is partially losing power. Test for a short-circuit, especially if much heating develops.

(c)—There may be a loose or a broken connection in the shunt field. Test and trace the circuit.

(d)—Perhaps there is a burned-out field rheostat. Test the rheostat, and if it is totally destroyed, it will be necessary to replace it. If it is partially damaged, such as in a single coil or resistance element, it may be possible to bridge it temporarily, or to get along with a reduced load.

(e)—There may be a defect in the field coil. Test it and, if possible, remedy the fault.

(f)—The brush setting may be improper. Note the setting and correct it if it is faulty.

(g)—The shunt or the coil connections may be reversed. If any leads have been disconnected recently and this develops, first look here for trouble.

(h)—A dirty commutator and dirty brush faces will also cause this trouble. Clean these parts.

(i)—This trouble may also be due to poor brush-commutator contact, burned-out brushes, or to the fact that the springs are carrying the current. This is probably your trouble if the heat is excessive here.

(j)—The brushes may be sticking in the holders. Test these and clear them.

(k)—The residual magnetism may be low, or lost entirely. If no other cause has been found, try to induce it artificially from another current source of controlled volume, until the motor picks up its magnetism.

(l)—Loose or heavily corroded contacts or joints may be the cause. Trace for these and correct them if found.

3. Low Voltage Continues

(a)—The reasons for this trouble are similar to those listed under the preceding section 2, headed "Voltage Does Not Build Up As It Should When Set Is Started."

4. Voltage Builds-Up Although Set Is Running Idle (Series-Arc Equipment)

(a)—Both short-circuiting switches are not closed, therefore this condition engenders dangers, such as overheating and undue strain on the motor. Never let a series-arc equipment run idle with the short-circuiting switch open, especially where the switch is part of the equipment. This strains not only the motor but also the voltmeter.

PICTURE DEFECTS

1. Action Is Not Natural, But Is Fast, Slow, Jerky, Etc.

(a)—The motor drive of the projector may not be operating properly. The line voltage may be altering considerably. Note the line voltage; and if it is not caused by that, look for loose or corroded contacts or connections to the drive motor. Note these and correct them if they are faulty.

2. Clearness of Picture Is Reduced After Lenses Are Removed and Replaced

(a)—The lenses may have been re-assembled incorrectly. The front combination and the rear combination may have been replaced in the wrong manner. If the rear element is composed of two separate pieces, it may have been replaced incorrectly. Note if the thicker, cemented element is at the front, and if the heaviest convex side is toward the screen. Always lay the lens elements, when they are taken out, on a soft cloth in the order in which they are removed, and return them in the same order in which they were removed.

3. Clearness of Picture Is Reduced After New Lens Is Installed

(a)—If only part of the combination is new, then the new element does not match the former element exactly. Always send the old element which is to be replaced to the maker so that it can be matched exactly.

(b)—If the entire element is new, the lenses may have been incorrectly assembled in the tube. If possible, secure a drawing of the correct assembly and check it with the position of the elements in the set employed.

(c)—The wrong lenses may have been ordered, or wrong lenses may have been sent in the place of those which were ordered. Perhaps some elements of different focal length may have been sent. Compare the lenses received, visually and in the screen test, with the old assembly.

4. Definition Becomes Poor; Clearness Is Reduced

(a)—Oil, finger marks, and dust are held in an oily film which covers the lens surfaces. The lenses may have been cleaned carelessly with a dirty cloth. Inspect the lenses and clean them with a half-and-half solution of water and alcohol, using a clean, soft and lintless cloth. Polish the lens while it is wet, but do not dry it hastily with an old cloth or piece of paper, because the surface will be spoiled.

5. Flashes of White Light Show on Screen During Projection

(a)—The film has not been scraped to a straight edge when it was prepared for splicing, or perhaps the splice did not overlap precisely.

FLICKER

1. Flicker Shows When New Screen Has Been Installed

(a)—The new, cleaner surface has increased the screen brilliancy so that the light interruption is now noticeable. This flicker, although it was not noticeable with a lesser illumination, will now become pronounced. Decreasing the size of the picture will decrease the tendency of the flicker to become pronounced under changed conditions, and an adjustment of the shutter, or a readjustment of the shutter blade width, will remove the trouble.

(b)—When a new screen is employed and the flicker becomes extremely pronounced, it is due to the following:—since the relation of the speed of the intermittent movement, which actuates the film travel, bears a definite relation to the width of the shutter blade permissible at given speeds, notice if the intermittent and the shutter blade width are at fault due to a sluggish movement of the intermittent or a slight excess of width of the master blade of the shutter. The increase of brilliancy of the new surface makes the alternation of light and dark

more apparent. Taking up the wear in the intermittent may enable you to trim the shutter blade and in this manner meet the increase in brilliancy and eliminate the noticeable flicker.

2. Flicker Noticeable When Amperage Is Increased

(a)—The reasons for this are the same as those enumerated under section 1, headed "Flicker Shows When New Screen Has Been Installed."

3. Flicker Increases When Size of Picture Is Increased

(a)—This is due to a natural law of optics. If you do not wish to decrease the amperage, which is the lazy way to eliminate noticeable flicker, a slight increase of speed will eliminate it.

4. Flicker Noticeable With Two-Wing Shutter

(a)—The alternations of light and dark are too far apart under the speed and the existing light conditions. The persistence-of-vision effect is destroyed and eyestrain occurs. If the flicker is still pronounced after the two-blade shutter is cut to the lowest point possible under the existing conditions, then it is advisable to use a three-wing shutter.

5. Flicker Is Noticeable When Projection Speed Is Reduced

(a)—The relation of the elements is altered, the blades cut the light less rapidly, and the inter-

mittent shifts the film a shade more slowly and at fractionally longer intervals. The persistence-of-vision effect is now destroyed. Once a proper balance of all the elements has been obtained at the correct projection speeds, it is best not to drop the projection speed to a point where the flicker shows. If the speed is dropped, there is no remedy except a complete readjustment with a probable disorganization of the conditions at greater speeds.

FOCUS

1. Focus Is Not Sharp: Keystone Effect is Pronounced

(a)—Where the projection room location is such as to compel a greater or lesser degree of keystone, out-of-focus projection is always present and cannot be wholly eliminated under the existing conditions.

(b)—"Stopping down," or reducing the aperture of the lens, as is done with a hand camera shutter, will, of course, sharpen the focus, but the decreased lens opening also decreases the amount of light projected. If the lenses are clean, and are kept so; if the focus is the very sharpest the lens will give under the conditions prevailing; and if the lens which is used is the best for throw, light, etc., nothing more can be done to remedy this condition.

2. Focus Appears Sharp From Projection Room, But Is Poor in Parts of Auditorium

(a)—In this case, the projection room is located so far from the screen that the projectionist's judgment of the screen focus is affected. Testing

the focus under these conditions, by having an assistant in the house when no show is on, will enable the projectionist to create a system of focus-compensation which will eliminate this trouble. The assistant should note when the focus is sharpest in the auditorium and the projectionist should mark the positions of the lens adjustments and in the future make mental allowances for this focusing. By slightly adjusting the lens according to a comparison of the projection room test results with the auditorium test results, a fair degree of accuracy can be secured. The use of a good lens and plenty of light will also help to remedy this difficulty.

3. Focus Bad, Out of Focus, In-and-Out Effect

(a)—These troubles may be due to the following conditions:

1. Old, shrunken film, which causes buckling. If such film must be used there is no remedy for this trouble.
2. Badly worn aperture plate tracks. Adjust the tension on the tension shoes, the film pad, or the springs. Inspect them, and if they are worn, they should be replaced.
3. Dirt and emulsion have been deposited in the aperture or on the tracks. Clean these, but do not use a sharp-edged tool

which will scratch or spoil the surface. Wash the parts with a damp rag or scrape them gently with a silver coin.

4. There may have been a slight misadjustment of the focusing screw. This should be checked and readjusted, otherwise it accents any change in the sharpness caused by the shift or by a very slight buckling of film.
5. The film trap is warped. This should be corrected or replaced.

LIGHT CONDITIONS AND THEIR EFFECT ON THE SCREEN

1. Blue Spot in Picture or in Light in Center of Screen

(a)—This may be due to a faulty alignment of the light source and the collector. The condenser may be too close to the aperture, or the crater is advanced too close to the condenser. Note which of these is at fault and readjust it.

2. Definition of Picture Poor

(a)—This may be due to slight unintentional misadjustment of focus, which should be corrected if found at fault.

(b)—A discoloration of the condenser which is reducing the clearness of the light, may cause an effect which gives the impression of poor definition. Note if the condenser has become discolored, and if it has, try changing the condensers.

(c)—A cheap lens, a poor lens made of low grade optical glass, or a lens which has been ground imperfectly, are some of the common reasons for

this trouble. If the definition is poor when a new lens is installed, any one of these three reasons is probably the difficulty.

(d)—This may also be due to improperly assembled lenses or to an imperfectly adjusted optical train. This should be checked and corrected if any fault is found.

(e)—There may be some dirt or oil on the lenses or between the glasses of the condenser of the projector. Examine these parts and clean them, if necessary.

(f)—Examine the film, for it may be that an oily or dirty section is being run at the moment when the definition appears poor.

(g)—If the screen in use has a highly reflective surface, too much light is being employed. If this is found so, reduce the light.

3. Detail Lacking in Screen Result

(a)—Examine the print first, for the trouble may be inherent in the print.

(b)—Occasionally a screen surface is of such a nature that it causes an effect of sharp, harsh lighting, thereby causing the pupil of the eye to contract voluntarily in order to overcome it. In this state the pupil admits only the highlights and the deep shadows and gives the impression of lack of

detail even though the print shows good detail. The only remedy in such a case is to obtain a new screen surface.

(c)—Dust has been allowed to settle on the screen until it has become coated and no longer gives a sharp, accurate reflecting surface. The screen should be cleaned or re-surfaced.

4. Dirty, Smoky, Smudgy Light Effect on Screen

(a)—This may be due to the use of a low voltage which compels the carbons to be so close together that the arc is not held at a proper point and therefore wanders. Increase the voltage slightly and note if the effect improves.

(b)—The motor generator may not be delivering the voltage it is supposed to be delivering. Check the voltage at the generator with an accurate voltmeter, and if the trouble is found here look under section headed, *Motors and Motor Generators.*

5. Light Seems to Get Bright and Fade Away With A.C. Arc

(a)—Due to the fact that A.C. cycles have points of full voltage and of no voltage, they give off an effect, similar to that of a shutter, of vivid lighting and of cutting off the light. Although this is not noticeable at the ordinary frequency because

of persistence-of-vision, any decrease in the number of cycles per second will cause an effect of lowered light intensity on the screen—that is, provided that the decrease in the number of cycles per second brings the no-voltage period into synchronization with the period when the shutter is open. As the synchronization, due to the shutter speed and its coincidence with the cycle changes, comes closer to completeness, or falls away, the light will seem to increase or to decrease in brilliancy. This fading up and down will occur sometimes in slow cycles, sometimes intermittently, and sometimes only for a short period. If this fading is persistent, try changing the speed of the projector, for it may serve to rectify this trouble provided the change in the cycle alternations is only temporary. If this condition is prevalent and a two-wing shutter is being employed, adjust it to a synchronous speed.

6. Light on Screen Poor With Incandescent Lamp

(a)—When changing to incandescent as a light source, if the illumination is poorer than that of the former light source, it is to be remembered that the light is softer and less vivid than that of a "hard" type of arc light. In this case you may be discrediting the "soft" light. Before reaching a definite conclusion, it is advisable to try the "soft" light for a while.

(b)—The former light may have given a sufficient degree of brilliancy with a dirt-encrusted, old-surfaced screen, but the "soft" light will show a marked decrease of brilliancy against this same dull and dingy surface. A clean, bright screen may completely change any contrary opinions.

(c)—If after using the lamp the light on the screen appears poor, the lamp may have lost its light intensity through age. If you have been overloading the lamp or working it above the rated capacity in order to get a more brilliant screen light, its life may be greatly shortened and its loss of intensity very marked after a short use.

7. Lacking Detail in Picture With Incandescent Lamp

(a)—This is most probably due to the same reasons as those listed under section 6, headed, "Light on Screen Poor with Incandescent Lamp."

8. Light Unusually Poor With Mazda

(a)—The lamps are not being operated up to a rated amperage. Test the amperage and also test the ammeter for inaccuracy, if the amperage reading is normal and the light is not.

(b)—The lamp is being employed after its useful life period has passed and it has lost its illuminating power. The only remedy is to install a new lamp.

(c)—The optical train may not be properly aligned and, therefore, the light is being wasted. This should be corrected.

(d)—There may be some dirt and oil on the lenses. These should be cleaned.

(e)—The lenses used are not suited to prevailing conditions. Consult the lamp maker's suggestions as to the proper optical conditions and secure the correct lenses.

(f)—The optical system is improperly spaced and therefore the full advantage of the light is not being taken. This should be tested and corrected if necessary.

(g)—The shutter employed may be of the wrong type, thereby cutting off too much light. If this is noticed with a three-winged shutter, try a two-winged shutter properly set and adjusted.

(h)—The mirror may not be properly set in order to give the fullest light compensation. This should be tested and adjusted.

(i)—The lamp filament has been short-circuited or warped out of alignment and therefore the light has been decreased or wasted. Examine the lamp, and if this is found to be the trouble, replace it.

(j)—The condenser is not properly adjusted in relation to the mirror and to the balance of the optical train. Test this and correct the adjustment.

9. Poor Light With High Intensity Arc

(a)—An incorrect amperage, to which the high intensity is extremely sensitive, may be the cause of this trouble. To remedy this follow the maker's instructions.

(b)—Dirty, carelessly cleaned, ash-dulled mirrors may also cause this trouble. These should be cleaned or replaced.

(c)—The positive contact shoe surfaces are corroded, or the ground may have become too large due to constant cleaning.

10. Uneven, Unsteady High Intensity Light

(a)—This may be due to excessive current. Check the current, and if the meter reads normal, check the meter. Be sure to use a rated current for the carbons and the lamp. Also, be sure to use the proper carbon sizes and types for the current used.

(b)—The arc length may be excessive and is therefore causing this trouble. Adjust the arc length by hand to better it slightly and adjust the controller to feed for a slightly shorter carbon separation.

(c)—Occasionally this trouble is due to a bad carbon and it often occurs with poor, cheap carbons to which this arc is very sensitive. The best results

can only be secured by the use of the best grade carbons of the correct size and type for the amperage employed.

(d)—The carbons may not be properly aligned. These should be examined and corrected if they are found faulty.

(e)—A draughty lamphouse is another common cause for this trouble. In this case, the gas is being blown out of the crater by strong air currents on the carbon tips. Ample ventilation and clean vents are extremely important. Avoid openings which allow strong air currents to blow on the lamp or on the carbon tips.

11. Poor Lighting With Reflector Arc

(a)—Crater position is bad, crater angles, etc. Look under section headed, *Light Source.*

(b)—The mirror may not be at a correct distance from the arc and is therefore wasting the light. This should be corrected.

(c)—Look for oil or dirt on the lenses and see whether the mirror is dirty, for these are constant sources of this trouble.

12. Lighting Glarey and Harsh When Light Source Is Changed

(a)—In all probability the screen is not adapted to the new lighting. The various arcs such as

the ordinary, the high intensity, the reflector, and the sunlight, differ in their light tones, and all of them differ from the light tone of the incandescent lamp. They also differ in brilliancy and degree of whiteness, for a light that shows up quite well on a dull, dingy screen, will be harsh and glarey on a clean, bright surface. In an emergency, the change from D.C. to A.C. may produce an unpleasant effect on some types of screens. This trouble cannot be helped if the light and lenses are in perfect order.

13. Glare Spots Show Up

(a)—An impression of glare is caused by the highlights in an over-brilliant picture, which has a great contrast between the highest lights and the deepest shadows. The light brilliancy should be reduced when these scenes are again shown.

(b)—A highly reflective surface is throwing the reflection of an adjacent light upon the screen. If this is so, look for the following as sources of this trouble:

1. A door which leads into a room having a bright light or a mirror in line with some part of the screen may be open.
2. A glossy wall and reflected wall lights may be the cause.
3. The musicians' lights may be reflecting from their music onto the screen.

4. A chink in a window covering, or a crack in a door admits the sunlight at such an angle as to strike the screen.

5. A brightly polished instrument in the orchestra catches the light and reflects it to the screen.

6. A stray light from the projection room, which is either in a direct line to fall upon the screen, or is being reflected upon it from the walls or a bright object, is a frequent trouble maker.

14. Gray, Flat Picture; No Contrast

(a)—First, note if the print is at fault—that is, whether it is under-exposed or over-printed, etc.

(b)—Dust may have settled on an oily lens surface, which should be cleaned.

(c)—This may also be due to a dirty, smoky screen and to the fact that dust has settled upon the screen surface. In this case the screen surface should be cleaned thoroughly.

(d)—Due to the density of the film the transmitted light has been decreased. Whenever this heavy part of the film is reached the light should be increased.

15. Light Shows Outside Screen Area

(a)—This may be due to the fact that the black coating on the inside of the lens barrel has worn, cracked, or flaked off and is therefore refracting the light. The inside of the barrel should be re-coated with dead black and should be inspected occasionally.

16. Light Loses Brilliancy

(a)—Dirt or corrosion may have decreased the current passage to the carbons. Inspect the carbon contacts. If a reflector arc is employed, note if the carbon, which is not straight, has changed the position of the arc crater. If a high intensity is employed, note if the carbon is making a poor contact, either at the end, at the carbon rest, or wherever the current passes into the carbon. If an incandescent lamp is employed, note whether the filaments are sagging or are short-circuited.

17. Picture Less Brilliant at Some Points in Auditorium Than in Others

(a)—In this case the screen may have deteriorated and may have lost its reflecting surface or diffusing power. The only remedy for this is a re-surfacing of the screen or the installation of a new screen.

18. Light Streaky With Incandescent Lamp Projection

(a)—The lamp may have a sagging, warped filament. Replace the old lamp and discard it if the new lamp corrects this condition. Otherwise, inspect the lenses to see whether there is any dirt, oil, or grease upon them.

19. Shadow Appears Near Top, Bottom, or Side of Screen

(a)—If a faint shadow is evident it is probably due to an incorrect adjustment of the gate on the projector. This trouble should be tested on a clear screen (no film running), and while the shadow is visible, lift the gate. If the shadow disappears, readjust the gate and center it.

20. Unsteady Picture

(a)—There may be dirt on the sprocket of the intermittent. This should be examined and cleaned.

(b)—This trouble may be due to vibration, either of the projector or of the floor.

(c)—It can also be caused by worn, loose, or vibrating parts in the intermittent or in the aperture assembly.

21. Unsteady, Side Motion of Picture

(a)—The guides at the gate are not set correctly thereby allowing "play." This should be corrected.

(b)—The aperture tracks are badly worn or an emulsion deposit is clogging them. These should be either replaced or cleaned and adjusted.

(c)—Vibration of the worn parts in the intermittent, or the fact that the sprocket teeth and the film claws are so badly worn that they allow "play" are also possible causes of this trouble.

(d)—There may be some strained or stretched sprocket holes in the film, or perhaps the film has a torn edge. Examine the film and eliminate those parts which are badly damaged.

22. Unsteady Picture, Although Projector is in Perfect Adjustment

(a)—Look for a carelessly made splice in which the sprocket holes are strained and not matched.

(b)—The dirt on the film which is being run is carried into the aperture tracks or lodges (in case of heavy tension) on the tension shoes. Keep the film free from contact with the floor or any other points where it can acquire dirt.

(c)—Due to hasty winding on poor reels, etc., the film may be nicked and serrated (saw-tooth), along the edge. Care in handling will avoid this trouble.

(d)—See whether the sprocket teeth are worn. If they are, a new sprocket must be installed.

(e)—This may also be due to weak tension on the tension springs. If this is so, adjust them.

(f)—If the intermittent sprocket shaft is bent, a new shaft will have to be installed.

(g)—Perhaps the eccentric bushing is worn. In this case a new bushing will be necessary.

(h)—Overspeeding the film will sometimes cause this trouble. If this is so, reduce the speed slightly.

23. Picture Seems to Float About on Screen

(a)—This, in all probability, is due to worn film guides or aperture tracks, or to the fact that a groove has been worn in the sides of the film track. In this case new parts are necessary.

(b)—Vibration and play in the worn parts of the intermittent.

TRAVEL GHOST

1. Travel Ghost Shows Up

(a)—The shutter revolving mechanism may be either slightly worn or loose, thereby allowing some "play" and a change of the shutter and intermittent relationship.

(b)—A misadjustment of the shutter may be affecting the travel of the master blade.

(c)—The shutter supporting rod may be slightly off "true," thereby, throwing the relationship of the shutter and the intermittent out of adjustment.

(d)—The master blade may have been trimmed a trifle too narrow.

(e)—The shutter may be at that part of the light beam in which it was not adjusted to work. Try it at a slightly narrower portion of the beam.

(f)—The speed may have slowed down to a point where the intermittent moves the film too much before the shutter cuts off the light, or after the shutter has passed and before the film is at rest.

2. "Travel Ghost" Intermittently

(a)—The shutter revolving device may have a worn part which allows an occasional slip or "play." This should be examined and corrected.

3. "Travel Ghost" Pronounced

(a)—The master blade of the shutter may not be wide enough.

(b)—The intermittent may not be adjusted to move and hold the film in its proper relation to the movement of the shutter and its action of cutting off and restoring the light to the screen.

(c)—Shutter not properly adjusted.

4. "Travel Ghost"; Picture Seems to "Crawl Up" on Screen

(a)—The picture will "crawl up" on the screen due to loose or worn framing device, which should be tightened to overcome this trouble.

5. Uneven Light, Noticeable Most on Plain Screen

(a)—This may be due to a poor "screening-out" (elimination), of daylight or reflected light. This does not show enough to form a glare spot, but it makes a difference in the lighting of the screen surface and is most apparent when no projector light is thrown on the screen surface.

(b)—A high amperage with poor condenser allocation allows the crater or the filament image to project onto the screen and will cause over-lighted and under-lighted areas.

(c)—If a reflector arc or an incandescent lamp is employed, improper placing of the condenser or of the mirror will cause this trouble. In this case much light is wasted and that light which is used is concentrated either in the center of the screen or at its sides. The condenser or the mirror should be adjusted.

STEREOPTICON TROUBLES

Noticeable on the Screen

1. Stereopticon Picture Smudgy-Looking

(a)—There may be some oil or dirt on the slides. Clean the slides very carefully.

(b)—Perhaps there is some oil or dirt on the optical system. This should be examined and then cleaned and polished.

(c)—Not properly focused.

2. "Ghost" in Center of Stereopticon Picture

(a)—In this case the condenser and the arc may not be in proper relation to each other, and therefore the space between them should be either increased or decreased.

(b)—The optical train may not be correctly aligned—that is, the elements may be either out of adjustment with one another, too close together, or too far apart. It is, therefore, necessary to readjust them.

3. Yellow Corners in Stereopticon Picture

(a)—The reasons for this are the same as those listed under section 2, on page 123, headed " 'Ghost' in Center of Stereopticon Picture."

4. Both Pictures of Dissolving Stereopticon Fail to Be in Register

(a)—In this case, the lenses may not be perfectly matched. If a new lens has been installed, test the device with the old lens system and correct the fault.

(b)—Another reason for this trouble is the fact that the manufacturer may have provided unmatched lenses. To test this, project a standard slide from one of the lenses (top lens), and mark, exactly, the limits of the picture on the screen. Then superimpose upon this marked space the same slide projected by the other lens (lower lens). If the picture thus projected from the lower lens does not match the marked space, do the following: remove the lower lens from the lower element of the stereopticon and substitute the upper lens in its place. Then re-project the same slide from the lower element. If the picture, thus projected, is superimposed exactly within the marked space, it means that the lower lens, which was removed, was not matched perfectly by the manufacturer and should therefore be changed. This test should be applied

to both of the lenses. First, as it just has been described; and second, by going through the same process and substituting the lower lens in place of the upper lens.

(c)—The failure of the pictures to register properly may also be due to the fact that the elements of the device, either the upper or the lower one, may be out of "true." To test this condition note whether the picture, projected from the top element, is matched exactly by the picture projected from the lower element when the top lens has been substituted in the lower mount in place of the lower lens. If the pictures do not match, and you are sure that the standard slide used in both elements has not shifted, then the lower element of the device is off "true." Test the upper element in the same manner and, if possible, readjust the elements until the register is perfect. However, this should be done only when it is known that no damage has occurred during the transportation or the unpacking of the device.

(d)—The slide carriers of the two devices may be out of perfect "true," causing even the same slide and the same lens not to give a correct register in both of the elements. If the slide carriers are adjustable, experiment with them and, if possible, block up the one least in condition. Always use the

same slide in testing both of the elements, otherwise all of the tests will be worthless.

5. Stereopticon Device Shows Break in a Condenser, Although Projector Does Not

(a)—This is a natural condition, for the stereopticon condenser is right up against the slide and any imperfection in it is focused right along with the slide and is thus projected. In the projector, however, the condenser is not focused, for its light, and therefore its defects, are focused on a different plane from that in which the film is focused.

6. Shadow of Carbons and/or Holders Appears When Using Reflector Arc for Stereopticon

(a)—Undoubtedly, the manufacturer's instructions have not been followed concerning the method of shifting over the lamphouse, and therefore, the system is not in correct position. In this type of device, the mirror and the slide position must be altered according to the method given by the manufacturer, else the carbon shadow will be projected, and, sometimes, even the full image of the carbon and its holder.

(b)—When the device is properly adjusted, that is, when, in order to prevent the carbon image from showing on the screen, the condenser is off the center, there are prisms provided for returning the

light beam to its normal path. If the light beam develops any troubles, look for a damage or a shifting of these prisms and if possible, correct, readjust, or replace them.

7. Stereopticon Slides Crack Excessively

(a)—If the stereopticon is used as a separate unit, that is, away from the projector, the amperage employed is probably too high for its needs, and overheating results. In this manner the slide has to be kept in the light and the heat so long that it cannot stand the strains imposed upon it. It, therefore, becomes overheated, expands, and then cracks when it is removed and allowed to cool suddenly. The remedy is a reduction of the amperage.

(b)—If the slides are being projected on the film projector, the amperage used for the film is probably much more than that which is required for the stereopticon work. Reduce the amperage.

(c)—If the slides are piled up in stacks while they are still hot, they will, undoubtedly, crack. For, while they are cooling they are put under the stress of the weight of the slides piled above them.

Note: Water jackets, which will eliminate all slide cracking, are now being manufactured for use with the double dissolving stereopticon.

PROJECTOR

1. Fire Shutter (Automatic) Sluggish

(a)—This may be due to the fact that the governor, and especially the friction shoes, are over-oiled. It is advisable to use a heavy oil on these parts and that only in very small amounts. Too much oil allows a slippage of the governor contact and makes the action on the shutter undependable.

2. Fire Shutter Rises Slowly, Drops Too Soon if Speed Is Slightly Reduced

(a)—The governor is undoubtedly out of adjustment. It should be examined for wear, loose parts, and misadjustment, and should be corrected wherever any fault is found.

(b)—The governor friction shoes are over-oiled. Less oil should be used.

3. Fire Shutter Fails to Work

(a)—This, most probably, is due to a broken or disconnected governor. Examine it and adjust or replace the broken part.

4. Film Buckles

(a)—This may be due to extreme wear of the aperture plate. If it is worn down or uneven, replace it.

(b)—Incorrect tension will also cause this trouble. The tension should be examined and adjusted.

(c)—The corners of loose patches may be catching or binding. All splices must be welded right out to each edge, the sprocket holes must be matched carefully. No free edges should be found on the film, especially that edge which comes in contact with the tension shoes while passing through the projector.

5. Film Climbs Sprocket

(a)—The sprocket idler may be badly adjusted, having more pressure on one side than on the other.

(b)—Dirt, oil, film cement, and emulsion are deposited on the teeth or other parts of the sprocket assembly. These parts should be cleaned.

(c)—The replaced sprockets are not truly lined-up. Be sure the alignment with all the parts in the film line of travel are exactly in line with one another.

(d)—Worn intermittent sprocket teeth will also cause this trouble. Replace the sprocket, but do not reverse it.

6. Friction Drive of Arc Controller or Motor Drive Wears Excessively

(a)—This may be due to poor leather facing, which should be replaced with a better grade.

(b)—Too much tension between the driving disc and the friction material will also cause this trouble.

7. Friction Material Develops Flat Spots

(a)—The controlling lever, undoubtedly, has been left in position when it was idle, and therefore an undue pressure has been exerted on certain points. Watch this in the future.

(b)—The disc covered by the material is not running true and therefore bears more at one point than at other points. The friction material may not be the same thickness at all points and so may have worn unevenly. If you are unable to correct the fault by carefully removing the excess material until it is even all around, it will be necessary to obtain some new material which is even throughout.

8. Friction Drive Fails to Operate Projector

(a)—The motor may be out of order. If any

fault is found with it, look under the section headed, *Motors and Motor Generators.*

(b)—Inspect for loosened or broken connections and adjust or replace them wherever necessary.

(c)—The disc may not be in engagement with the drive discs. This should be noted and corrected, if found.

(d)—Oil on friction drive and disc. Remove it.

9. Friction Drive Operates Off-and-On

(a)—This may be caused by insufficient tension between the drive disc and the friction material. Tighten the material just enough to cause it to operate but not so much as to damage or wear it rapidly.

(b)—Oil or grease may have gathered on the friction material. Those types which are affected by this should be cleaned carefully. Be sure that the oil is removed from all the parts with which it has come in contact, including the leather and the metal as well.

(c)—The adjustment material may have worked loose and should, therefore, be corrected.

10. Governor Type Drive Operates Badly

(a)—The speed control knob or the adjustment are not in their proper positions. See to it that the

springs or any other device for pressing the drive discs together, are not broken or loosened.

11. Governor Drive Fails

(a)—The motor may be at fault. If it is look under section headed, *Motors and Motor Generators.*

(b)—The spring or any other mechanism which holds the friction disc is either out of adjustment or broken. This should be examined and adjusted or replaced.

12. Thrust Disc Operates Poorly

(a)—The knob, or level, which controls the introduction of the thrust disc between the drive disc, is incorrectly adjusted. Increase or decrease the amount of tension or movement as required to provide a perfect drive condition.

(b)—The thrust disc may have some oil on it. Clean the disc and all the parts with which it contacts.

13. Motiograph Speed Control Operates Poorly

(a)—The control of speed in this type is obtained by rocking the motor on the shaft, therefore, note if this mechanism is out of adjustment. Regulate it to suit the needs.

14. Baird Speed Control Operates Poorly

(a)—In this case, the friction wheel is either too tight against the disc or it is too loose. Adjust it to meet the existing condition.

(b)—The pulley belt may be slipping. Examine it and tighten or apply non-slip dressing.

15. Intermittent Wears Excessively

(a)—This is often due to the use of a graphite lubricant, of cheap, dirty, and poor oils, and of oils which are either too light or too heavy. Failure to change the oil often enough will also cause this.

(b)—Friction is caused by setting up the mechanism too tightly, for the mechanism should work easily but without much play.

16. Lower Loop Constantly Lost as Splices Come Through

(a)—Dirty sprockets will cause this. Clean them and remove all that have worn teeth.

(b)—One side of the sprocket teeth is more worn than the other, therefore it is necessary to replace the sprocket.

(c)—Uneven sprocket alignment will also cause this. Correct the alignment.

(d)—Bad film splices are a constant source of this trouble.

(e)—If a friction take-up is employed, the tension is set far too heavy. Adjust it to that exact degree at which it will function without trouble.

(f)—The idler may not have been properly set, therefore adjust it.

17. Parts, Bearings Wear Rapidly

(a)—The dust in the air settles on the parts which will wear if they are not kept clean. The dust may also have been carried into the bearings with dirty oil. Cover all oil in order that it may be kept away from dust.

(b)—This may be due to a misadjustment of the parts. Follow the manufacturer's instructions in installing the parts.

(c)—Perhaps the adjustments are being kept too tight. Set up the parts just tight enough for proper operation but not so tight that the parts can bind. For, even if the parts are lubricated this binding causes the wear to slowly pulverize the metal, and the grinding effect of this, mixed with the oil, causes the metal to wear very rapidly.

18. Mazda Mirror Images Do Not Fall Exactly Between Filament Images

(a)—The mirror has been slightly misadjusted, or it has been moved out of its correct position,

due to a loosened adjusting control. Readjust the mirror and tighten it enough to hold.

(b)—If a new lamp has been installed, the manufacturer's instructions may not have been followed for an accurate placing of the lamp in its base or socket. Always adjust the lamp correctly.

19. Tension Applies Only to Lower Magazine, Not Upper

(a)—The reels may be in bad shape. Either they are out of true, or they may be bent. Use only perfect reels.

20. Tension Shoes Jump and Clatter

(a)—Cement and emulsion may have been deposited on the face of the shoes. Wipe the shoes with a water-wet rag and then dry them. Do this quite often and avoid trouble.

(b)—This may be due to loose parts which are worn or misadjusted. Examine these parts, test them, and then either adjust them or replace them.

RHEOSTAT

1. Amperage Does Not Change When Rheostat Adjustment Is Altered

(a)—The meter may be reading inaccurately, therefore test it with a connected meter first.

(b)—There may be a poor or dirty contact between the moving arm and the point. Clean it and smooth it down.

(c)—The handle of the adjusting member may be loose or slipping. Test it and if necessary, tighten it.

(d)—The rheostat wire may be badly burned or it may be completely burned out. Test and replace it.

(e)—There may be a bad connection within the wiring, the coils, or the grid system. Examine and remedy the fault if it is found.

2. Rheostat Coil or Grid Burns Out

Emergency Repair (temporary): In bridging the burned-out coil or grid use a strongly insulated (asbestos insulated), wire, which is capable of carrying the current. The bridge should lead from the

live end of the last good coil, or grid, ahead of the damaged one, over the damaged one, and on to the end of the next good coil, or grid, with which it formerly had a contact. It is best to cut the damaged coil, or grid, out of the circuit and to remove it entirely in order to prevent the possibility of its being sagged or bent. For, if it is sagged or bent it will ground the bridge to the frame.

3. Rheostat Shows Visible Heating at One Point of Coil or Grid

(a)—The coils may have sagged together, or, the grid (infrequent), may have bent so that it touches the adjoining member or makes a partial contact with the frame. If it is impossible to correct the sag of the coil, or the bend of the grid, they should be removed and replaced. A temporary repair can often be made, provided the coil or the grid has not burned-out, by putting some powerful insulating material, such as asbestos sheeting of good thickness, between the contacting coils, the contacting coil and the frame, or the contacting grid and the frame, as the case may require.

4. Rheostat Overheats and Does Not Operate Properly

(a)—Perhaps it is being overloaded, that is, it is working on a voltage which is higher than that of its rated capacity. In this case it is necessary to add

resistance elements or to reduce the load on the present installation. Overheating shortens the life of the rheostat and may involve a breakdown and other possible serious delays.

(b)—If it does not operate properly, it probably has been so continually subjected to an overload that the elements have finally broken down.

Note: Heating, within certain ranges, is essential to the operation of the rheostat, as the current is dissipated in the heat. But, the degree of heat must always be held within safe limits. Inspect the rheostat when the room is dark. If a barely perceptible ruddiness is apparent it is overheating a trifle, although not dangerously. If a dull red is apparent, although it glows instead of smoldering, the overheating is fairly dangerous to the life of the elements. If a bright cherry red is apparent, the rheostat is overheating seriously and it is apt to burn out or break down without warning.

5. Rheostat Fails to Pass Current

(a)—This may be due to a burned out coil or grid. Test and replace it or bridge it temporarily as directed in section 2, on page 136, headed, "Rheostat Coil or Grid Burns Out."

(b)—There may be a broken or loose connection from the line to the rheostat or from the rheostat to the arc. Inspect this and remedy it.

(c)—Heavily corroded contacts may occasionally arrest the flow of the current or reduce noticeably. Inspect the contacts and clean or tighten them.

(d)—There may be a broken or loose connection or a serious ground within the device. Inspect the device, and if the connections are secure, test it for a ground. Then test for broken down or damaged insulation at the points where the coils or the grids are joined. Finally, see if any grid or coil is contacting with the frame.

Note: If ordinary testing fails to show the ground, and no other cause is apparent, test as follows: Take the rheostat out of the circuit. Use a test lamp connected in a regular incandescent light socket. Put lamp in circuit and with free end of wire touch the other binding post. If lamp lights, there is no break or burned-out coil, and the circuit is complete. If lamp lights and goes out intermittently, there is bad contact somewhere within the device. Taking each coil or grid as a unit, disconnect it at the lower end from device—such as, coil one, disconnect lower end, touch lower (free), end with wire. A light or a ring shows that it is intact. Reconnect, then disconnect second coil and so proceed, disconnecting lower end of next one as soon as one tests correctly and is reconnected. When you come to one that gives an intermittent light, you

have located the trouble. If when it is disconnected at one end there is no failure of the lamp, then there has been a contact with the frame when it was connected into the circuit, or else there has been a contact with another coil or grid. Make sure by connecting one wire of tester to the frame and the other to a wire of opposite polarity:—if the lamp then lights, there is surely a ground to the frame. With a lead from arc to rheostat disconnected, and a lead from line to rheostat still connected, with one lead of test lamp attached to the rheostat frame and the other to wire of opposite polarity, then disconnect, one after the other, coils or grids from the frame: the one which extinguishes the lamp is the troublesome one and can be eliminated.

SCREEN

1. Screen Not Given Results Up to Previous Performance

(a)—This trouble usually is due to carelessness in keeping the screen clean and free from collected dust which settles on it. Careless rubbing with improper form of cleaning implement rubs-in the dirt instead of removing it.

(b)—Kalsomined or other white surfaces easily get dusty, the dirt adhering easily because of dampness. Hold a white blotter against the screen: —if the screen surface is less white than the blotter, it needs refinishing.

(c)—Metallized surface screens may lose their reflecting qualities because of chemical changes, dampness, and through inattention to proper cleaning methods.

(d)—Chalk surfaces soil and show the dirt quickly; but they can be removed from plaster foundation with a blackboard eraser and a new surface rubbed on, care being used to get on smoothly and free from swirls and uneven appearance.

(e)—Mirror screens may lose quality through deterioration; consult the maker for proper care and adjustment when quality is lost.

Warning: The first place to look for light loss and uneven light is on a carelessly cleaned or seldom cleaned screen.

SPOTLIGHT

1. Beam Falls Upon Audience, Causing Annoyance and Distraction

(a)—Improper masking of lower part of beam is often the cause of this trouble. Masks can be procured or cut to suit the apron line of stage, or to follow the curve of the orchestra pit if it is desired to include the orchestra for flood work. For spotting, a mask can usually be set at a lower point, somewhat in front of the beam that will be stationary when the spot is moved, but which will cut the light from falling onto the audience. This mask should be used, as many people with defective vision among the audience are annoyed by stray and vivid color lighting being allowed to get out of its proper sphere.

2. "Ghost" Shows in Spotlight Beam

(a)—Faulty carbon setting. It is the crater image which you project, so determined by test the best angle and setting to give desirable, clear crater, without clouding with shadows.

3. Rings and Shadows Show in Spotlight Beam

(a)—Improper setting of carbons. Adjust and test.

(b)—Wrong style, grade, or size of carbons—especially with A.C. An A.C. spotlight requires much care in choice of carbons and is likely to be hard to handle. Be sure that the carbons are not at fault.

4. Poor Lighting With Spot

(a)—In ordinary arcs lack of brilliancy is due to improper choice of carbons.

(b)—With A.C. the amperage materially affects the quality of the light, as also does the type of carbons used. Correct amperage and carbon grade and size and type should be chosen for the best conditions.

SWITCHES

1. Switches Heat, are Warm or Hot to Touch

(a)—Contact is not perfect:—either corrosion has set in or dirt has gotten into the contact jaws, or the connections at the binding posts are badly corroded or loose. Any of these will cause a heavy resistance to the current; these conditions result in heat, and heat engenders danger with switches. An overheated switch may break down at a burned contact and may become impossible to handle; sufficient heat may even be set up to weaken or destroy the insulation and loosen a live wire from its contact, thus creating as dangerous a condition as heavily overloaded wiring. Avoid this trouble by keeping all contacts clean and tight, and by cleaning out even a minimum of collected dirt.

EMERGENCY AFTER FILM FIRES

The parts may be gummy from the mixture of burned celluloid, emulsion and cement and should therefore be cleaned immediately. This may be cleaned most effectively and quickly by using ordinary, drug-store hydrogen peroxide. Wipe it off after cleaning the parts and keep a bottle of it handy for future use.

EQUIVALENTS

FORMULAS

ETC.

ELECTRICAL EQUIVALENTS

1 kilowatt = 1,000 watts.
1 kilowatt = one and 34 hundredths of a horsepower.
1 kilowatt = 44,257 foot-pounds per minute.
1 kilowatt = 56 and 87 hundredths British thermal units per minute.

1 horsepower = 746 watts.
1 horsepower = 33,000 foot-pounds per minute.
1 watt = 10 million ergs per second.
1 watt = .7373 foot-pounds per second.
1 watt = .00134 horsepower.

1 B.t.u., (British thermal unit) = 778 foot-pounds.

HYDRAULIC EQUIVALENTS

Gallon of water = in weight, 8 and 33 hundredths pounds.
Cubic foot of water = in weight, 62 and 4 tenths pounds.

METRIC EQUIVALENTS

Metric to Standard Length	Standard to Metric Length
Cm. = .3937 in.	Inch = 2.54 Cm.
Meter = 3.28 feet.	Foot = .305 meter
Meter = 1.09 yds.	Yard = .914 meter
Metric to Standard Area	**Standard to Metric Area**
Sq. Cm. = .1539 sq. in.	Sq. inch = 6.452 sq. Cm.
Sq. M. = 10.764 sq. ft.	Sq. foot = .0929 sq. M.
Sq. M. = 1.196 sq. yd.	Sq. yard = .836 sq. M.
Volume	**Volume**
Cu. Cm. = .061 cu. inches	Cu. Inch = 16.4 cu. Cm.
Cu. M. = 35.31 cu. feet	Cu. Foot = .028 cu. M.
Cu. M. = 1.308 cu. yards	Cu. Yard = .765 cu. M.

Capacity	Capacity
Litre = .0353 cu. feet	Cu. foot = 28.32 litres
Litre = .2642 gallon (U.S.)	Gallon = 3.785 litres
Weight	**Weight**
Gram = 15.423 grains	Grain = .0694 gram
Gram = .0353 ounce	Ounce = 28.34 grams
Kilogram = 2.205 lb.	Pound = .454 Kilogram

FORMULAS

Thermometer Reading

To convert CENTIGRADE to FAHRENHEIT:
Multiply by 1.8 and add 32

To convert FAHRENHEIT to CENTIGRADE:
Subtract 32 and then divide the result by 1.8.

Electrical

(For simplicity in use by those who have not had much practice in electrical calculations, no contractions or abbreviations are used.)

To Find Horsepower of Work performed by electric current:
Multiply figure representing number of volts by figure representing number of amperes and divide the result by the figure representing number of watts equivalent to 1 horsepower, which is 746. (Volts multiplied by amperes; divide result by 746)

To Find Amperes:
Divide number representing volts by figure representing resistance expressed in ohms. (Volts divided by Ohms = Amperes)

To Find Resistance in Ohms:
Divide number expressing volts by number expressing amperes.
(Volts divided by amperes = ohms)

To Find Volts:

Multiply figure expressing amperage by figure expressing ohms.

(Amperage multiplied by ohms = voltage)

Note: In applying electrical formulas to problems in projection, it must always be remembered that the arc voltage must be subtracted from the line voltage in order to arrive at a solution approximating conditions: for, although a voltage drop occurs in the wiring of the circuit, this can ordinarily be ignored; but arc voltage cannot, and thus voltage must be taken to mean line voltage *minus* arc voltage.

Note: In order to get the exact arc voltage, have arc burning at its best normal adjustment, then touch a terminal wire of voltmeter to each carbon, making a good contact: the reading will be the figure you want to subtract from the line voltage in calculating.

ARITHMETICAL FORMULAS

Fractions

To Add Fractions:

First, both fractions must be reduced to a common denominator, that is, each must be expressed in terms of similar fractional parts, as, to add ½ and ⅓. Both must be expressed similarly, which means, in this instance, as 6/12 and 4/12. Then the top figures can be added and the result will be 10/12, which can then be reduced to its lowest terms, which gives a result of 5/6. The procedure is to multiply both factors of each fraction by the denominator of the other. Thus:

$$\frac{2 \times 3}{4 \times 3} \text{ and } \frac{1 \times 4}{3 \times 4}$$

To Multiply a Fraction by a Whole Number:

Multiply the numerator
or
Divide the denominator } by the whole number

To Multiply a Fraction by a Fraction:

Multiply the numerator of one by the numerator of the

other; also multiply one denominator by the other; then, if possible to reduce the resulting fraction to lower terms, do so.

To Divide a Fraction by a Whole Number:

Divide the numerator
or
Multiply the denominator
} by the whole number

To Divide a Fraction by a Fraction:

Reverse top and bottom numerals of divisor and then multiply one numerator by the other and one denominator by the other.

MENSURATION FORMULAS

To Find Area of a Circle:

Multiply square of diameter by .7854
(To square a number, multiply it by itself.)

To Find Circumference of a Circle:

Multiply diameter by 3.1416.

To Find Diameter of a Circle:

Multiply circumference by .31831.

To Find Side of an Equal Square:

Multiply diameter by .8862.

To Find Area of Triangle:

Multiply base by one-half of Altitude.

To Find Surface of a Sphere:

Four times the radius squared, multiplied by 3.1416.

National Cored and Orotip Projector Combinations

(This and subsequent carbon combination tables used through the courtesy of National Carbon Co.)

For Direct Current

Arc Amperage		*Size Inches*	*Kind*
25– 50	Positive	5/8 x 12	National Cored Projector
	Negative	5/16 x 6	National Orotip Solid or Cored Projector
50– 65	Positive	3/4 x 12	National Cored Projector
	Negative	11/32 x 6	National Orotip Solid or Cored Projector
65– 70	Positive	7/8 x 12	National Cored Projector
	Negative	11/32 x 6	National Orotip Solid or Cored Projector
70– 85	Positive	7/8 x 12	National Cored Projector
	Negative	3/8 x 6	National Orotip Solid or Cored Projector
85–120	Positive	1 x 12	National Cored Projector
	Negative	7/16 x 6	National Orotip Cored Projector
120–140	Positive	1 1/8 x 12	National Cored Projector
	Negative	1/2 x 6	National Orotip Cored Projector

National White Flame A.C. Projector Combinations

For Alternating Current

Arc Amperage	*Arc Voltage*	*Diameter Inches*	*Kind*
25– 40	25–28	1/2	Combination
40– 60	28–32	5/8	Combination
60– 75	32–35	3/4	Combination
75–100	35–40	7/8	Combination

National Cored and Solid Projector Combinations for Mirror or Reflector Arc Lamps

Horizontal Trim Lamps

Arc Amperage		*Size*	*Kind*
10–15	Positive	9m/m x 8″	National Cored Projector
incl.	Negative	6.4m/m x 8″	National Solid Projector
16–20	Positive	10m/m x 8″	National Cored Projector
incl.	Negative	7m/m x 8″	National Solid Projector
21–25	Positive	12m/m x 8″	National Cored Projector
incl.	Negative	8m/m x 8″	National Solid Projector
		or	
		8m/m x 8″	National Cored Projector
26–30	Positive	13m/m x 8″	National Cored Projector
incl.	Negative	9m/m x 8″	National Cored Projector
31–35	Positive	14m/m x 8″	National Cored Projector
incl.	Negative	10m/m x 8″	National Cored Projector

Angular Trim Lamps

Arc Amperage		*Size*	*Kind*
6–10	Positive	9m/m x 8″	National Cored Projector
incl.	Negative	8m/m x 8″	National Cored Projector
11–15	Positive	10m/m x 8″	National Cored Projector
incl.	Negative	9m/m x 8″	National Cored Projector
16–20	Positive	12m/m x 8″	National Cored Projector
incl.	Negative	10m/m x 8″	National Cored Projector

National High Intensity Projector Combinations

General Electric Lamps

Arc Amperage		*Size*	*Kind*
50	Positive	9m/m x 20″	National H. I. White Flame Projector
	Negative	11/32 x 9″	National Orotip Cored Projector
75	Positive	11m/m x 20″	National H. I. White Flame Projector
	Negative	3/8 x 9″	National Orotip Cored Projector
100–120	Positive	13.6m/m x 20″	National H. I. White Flame Projector
	Negative	7/16 x 9″	National Orotip Cored Projector

H & C and Sunlight Arc Lamps

Arc Amperage		*Size*	*Kind*
50	Positive	9m/m x 20″	National H. I. White Flame Projector
	Negative	5/16 x 9″	National Orotip Cored Projector
75	Positive	11m/m x 20″	National H. I. White Flame Projector
	Negative	11/32 x 9″	National Orotip Cored Projector
100–120	Positive	13.6m/m x 20″	National H. I. White Flame Projector
	Negative	3/8 x 9″	National Orotip Cored Projector

ASHCRAFT LAMPS

Arc Amperage		*Size*	*Kind*
80	Positive	½ x 12″	National White Flame Cored
	Negative	⅜ x 9″	National Orotip Cored Projector
100 to 120	Positive	13.6m/m x 20″	National H. I. White Flame Projector
	Negative	⅜ x 9″	National Orotip Cored Projector

CARRYING CAPACITY OF COPPER WIRES

The following table, showing the allowable carrying capacity of copper wires and cables of 98% conductivity, according to the standard adopted by the American Institute of Electrical Engineers, must be followed in placing interior conductors.

For insulated aluminum wire the safe carrying capacity is 84% of that given in the following tables for copper wire with the same kind of insulation.

B. & S. Gauge	*Table A Rubber Insulation Amperes*	*Table B Other Insulations Amperes*	*Resistance per 1000 ft. in International Ohms At 75° F.*
18	3	5	6.567
16	6	8	4.04
14	12	16	2.565
12	17	23	1.601
10	24	32	1.01
8	33	46	.641 3
6	46	65	.400 4
5	54	77	.317 2
4	65	92	.252 5
3	76	110	.200 4
2	90	131	.157 9
1	107	156	.125 8
0	127	185	.099 48
00	150	220	.078 87
000	177	262	.062 51
0000	210	312	.049 66

The lower limit is specified for rubber-covered wires to prevent gradual deterioration of the high insulations by the heat of the wires, but not from fear of igniting the insulation. The question of drop is not taken into consideration in the above tables.

WEIGHTS AND MEASURES

Troy Weight

24 grains=1 pennyweight (dwt.) 12 ounces=1 pound
20 dwts.=1 ounce
Used for weighing gold, silver and jewels

Avoirdupois Weight

27 11/32 grains = 1 dram
16 drams = 1 ounce
16 ounces = 1 pound
25 pounds = 1 quarter
4 quarters = 1 cwt.
2,000 lbs. = 1 short ton
2,240 lbs. = 1 long ton

Dry Measure

2 pints = 1 quart
8 quarts = 1 peck
4 pecks = 1 bushel
36 bushels = 1 chaldron

Liquid Measure

4 gills = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon
31½ gallons = barrel
2 barrels = hogshead
16 fluid ounces = 1 pint

Long Measure

12 inches = 1 foot
3 feet = 1 yard
5½ yards = 1 rod
40 rods = 1 furlong
8 furlongs = 1 sta. mile
3 miles = 1 league
5280 ft. = 1 mile